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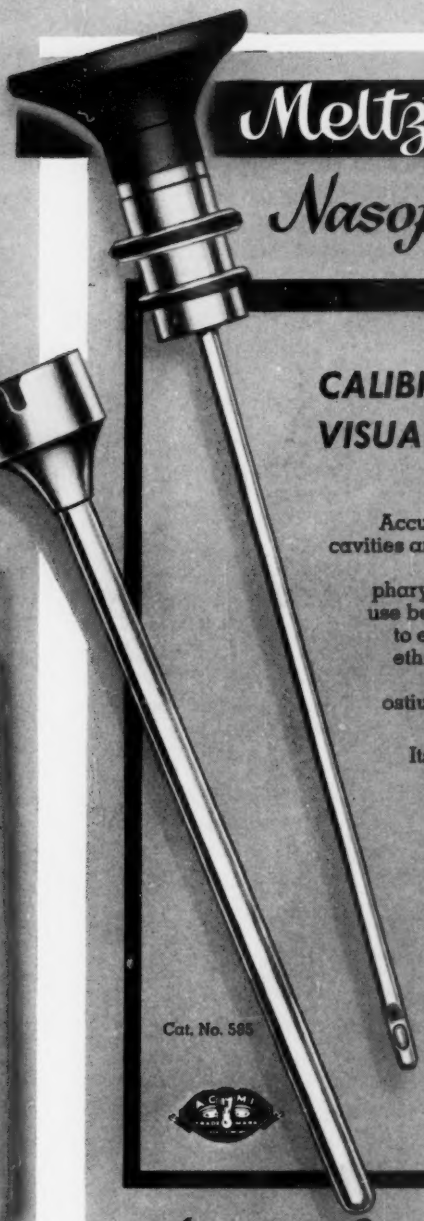

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The finest hearing aids in the world have been developed in this country.[1] Almost every hard-of-hearing patient can benefit by using one, yet only 30 per cent of those who buy aids wear them.[2] This is in marked contrast to the results achieved under the controlled conditions in the Army and Navy rehabilitation centers where 80 per cent of those fitted with aids continue their use.[2]

It is the responsibility of the physician to see that his hard-of-hearing patients are rehabilitated. His responsibility does not end with his diagnosis of the type of deafness from which his patient suffers. As Fowler [3] has pointed out, too many physicians tell their patients they have otosclerosis or suffer from a nerve deafness and dismiss them with the statement, "nothing can be done about it." He asks, "Is it any wonder that the patients are driven to try quackery?"

The physician should advise his hard-of-hearing patient to buy a hearing aid. He should take the matter with the utmost seriousness. A hearing aid needs more than a haphazard "over a counter" purchase. Repeated technical adjustments and demonstrations of its use will go far to increase its acceptability. The patient should feel confidence in the physician's interest in this matter which affects so profoundly an adjustment to a major handicap. Certainly the proper hearing aid, supplemented with auditory training and, possibly, lip reading, may do as much, if not more, than treatment itself can do.[3]

AIDS MUST BE WORN TO BE USEFUL

Undoubtedly there is a prejudice against hearing aids, and those who need them most probably have the greatest prejudice.[4] "Hearing aids still carry the stigma of senility," it has been said recently, "and consequently are socially unacceptable." [5] This is a concept which needs to be changed, and which can be changed, once it is recognized that hearing defects affect all ages, even children.

"The new understanding of the physiology of hearing and improved methods of examination have made possible," Kerman [6] states, "the development of hearing aids which are rapidly being improved." He believes it reasonable to suppose that in the future a hearing aid can be "fitted as competently as are glasses to the eyes."

With the newer, lighter, better-fitting, and less conspicuous hearing aids, undoubtedly prejudice against wearing them will vanish. However, the hard-of-hearing patient will still need encouragement to learn to use his instrument. Weeks or months of effort may be required before he can adjust himself to the aid.[7] A prolonged training process may be required.[8] Here the hearing aid technician can be most helpful. Always, the patient must be reminded that an unused hearing aid never helps its owner.

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Even as high a hearing loss as 85 decibels may be benefited by the use of a hearing aid.[9] Indeed, its use is justified if only background noise and some speech sounds are heard, for thus the hard-of-hearing is linked to the hearing world.

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The patient, however, must be helped to be realistic about his hearing aid. He may expect it to be "a panacea for all his difficulties," [10] which, of course, it will not be. He must understand its limitations, as well as its advantages—that, for instance, it will amplify all sounds,[10] and that sounds will be difficult to localize.[5]

Before, however, the physician starts the task of helping his patient adjust to an aid, he must make sure that the instrument meets the basic requirments of the office of Scientific Research and Development in the following particulars: "1. Power: It must have sufficient power to bring audible sounds to the deafened ear. 2. Tolerability: Sound must be brought to the ear without causing pain, tickle, or serious discomfort. 3. Fidelity: In terms of the patient's ability to interpret sound, the hearing aid should make intelligible any clear connected speech. 4. Wearability: The ear piece must be tolerable to wear, and the instrument as a whole must be portable without unreasonable discomfort and inconvenience. 5. Sensitivity and amplification: The aid must make ordinary speech intelligible at conversational levels." [10]

With care that the patient gets the aid accurately suited to the pattern of his particular handicap, with assistance in adjustment to using it, and encouragement in its use, a large number of hard-of-hearing persons now living isolated in the midst of the hearing world may be brought back to happiness. For it has been said that "rapid progress in the development of hearing aids has without doubt furnished the most important single factor in helping the hard-of-hearing person." [5]

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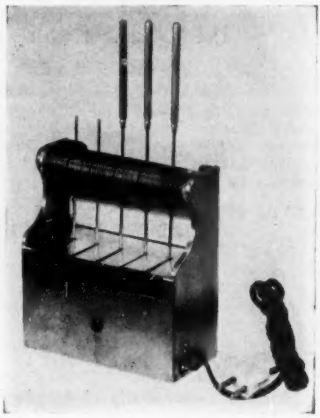

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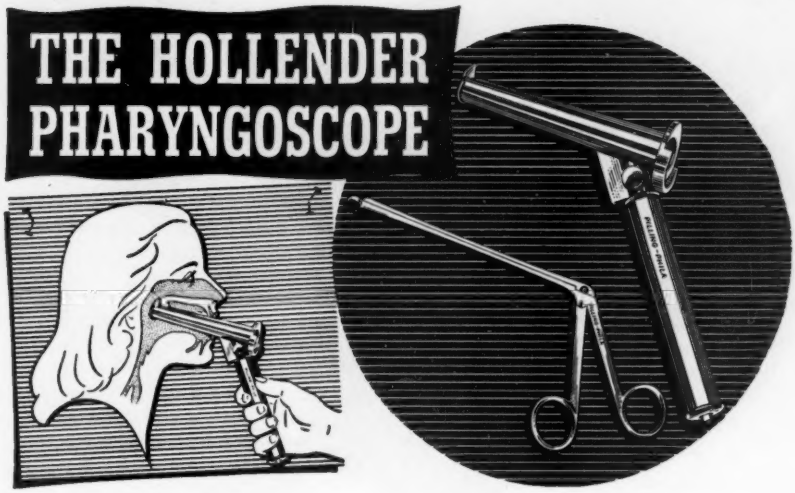

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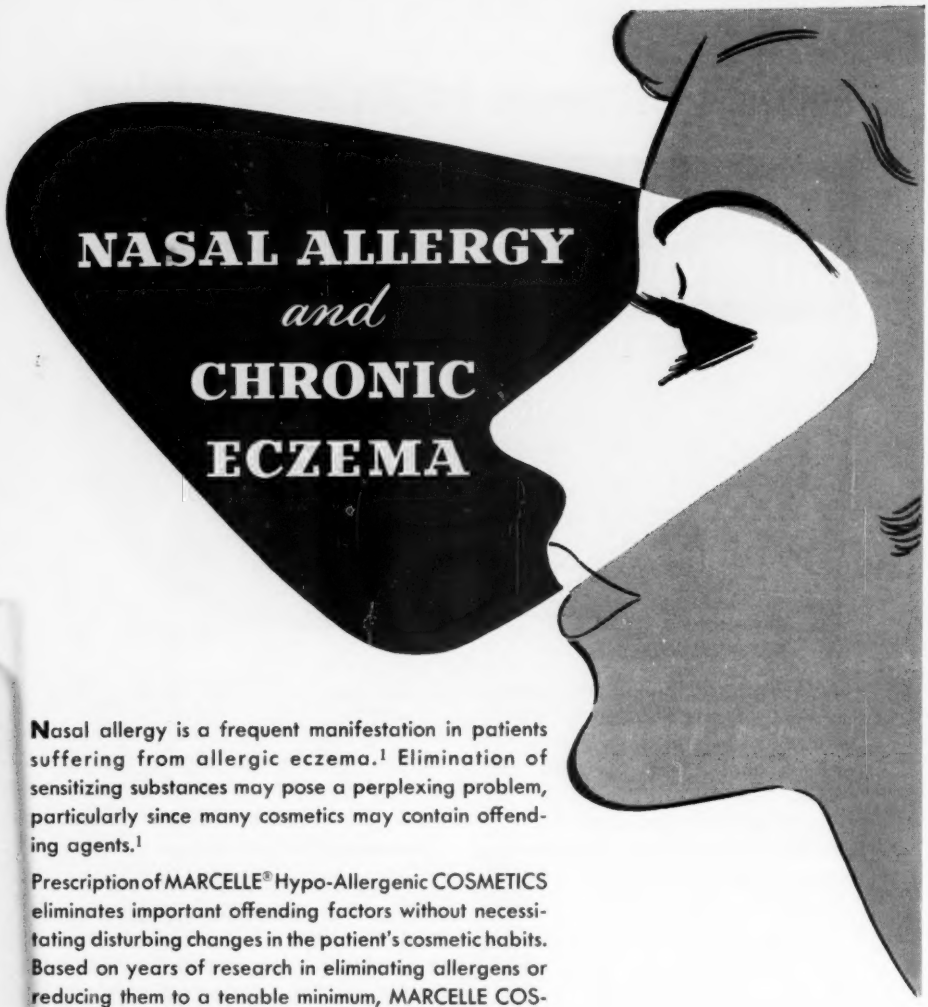

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STREPTOMYCIN THERAPY IN LARYNGEAL TUBERCULOSIS

CLAUDE C. CODY III, M.D.
HOUSTON, TEXAS

INVOLVEMENT of the larynx with tuberculosis has long been regarded as a rather grave complication of the original pulmonary disease,[1] and at one time patients with such laryngeal complications were barred from many of the various sanatoriums.[1a] Advanced pulmonary tuberculosis is practically always the forerunner of laryngeal disease, primary laryngeal tuberculosis apparently being extremely rare.[2]

Our knowledge of laryngeal tuberculosis can be traced back as far as Morgagni.[2b, c] However, real progress in understanding this disease was first made in the early nineteenth century by three great clinicians; Louis, Laennec and Trousseau.[2c] Even the medical student is familiar with some of the work and contributions of these masters of observation and physical diagnosis.

Attention to the larynx in the living patient assumed increasing importance after the introduction of the laryngeal mirror by the London singing teacher, Manuel Garcia, about 1855.[2d] A much more accurate study of the larynx followed, with surprisingly well detailed descriptions of the various laryngeal diseases.

The so-called laryngeal triad of syphilis, tuberculosis and cancer was subjected to considerable confusion by the pioneers in laryngeal work. Having to rely mainly on powers of observation, they attached the greatest importance to minute details of laryngeal pathology and thus handed down classic descriptions of the various laryngeal diseases. One cannot help but respect these original investigators, limited as they

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From the Department of Otolaryngology, Baylor University College of Medicine.

Candidate's thesis presented to the American Laryngological, Rhinological and Otological Society, April 1949.

1. (*a*) Thomason, St. C., and Negus, V. E.: Diseases of the Nose and Throat: A Textbook for Students and Practitioners, ed. 4, New York, D. Appleton-Century Company, Inc., 1937, pp. 700-744. (*b*) Jackson, C., and Coates, G. M.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929, pp. 868-893.

2. (*a*) Footnote 1. (*b*) Myerson, M. C.: Tuberculosis of the Ear, Nose, and Throat, Springfield, Ill., Charles C Thomas, Publisher, 1944, pp. 3-154. (*c*) Trousseau, A., and Belloc, H.: A Practical Treatise on Laryngeal Phthisis, Chronic Laryngitis and Diseases of the Voice, translated by J. A. Warder, Philadelphia, A. Waldie, 1839. (*d*) Jackson, C., and Jackson, C. L.: Diseases and Injuries of the Larynx: A Textbook for Students and Practitioners, ed. 2, New York, The Macmillan Company, 1942, pp. 233-244.

were in laboratory studies, when most of us even now experience trouble in making a diagnosis with such facilities available as serologic studies of the blood, sputum studies, excellent chest roentgenograms and accurate microscopic tissue studies. We know today that inspection alone is a highly inaccurate means of making a diagnosis, and, because of the possibility of coexisting lesions, every facility available should be employed in reaching a decision.

Until the beginning of the year 1944 the management of laryngeal tuberculosis had remained essentially unchanged for over 35 years.[3] True, the incidence of severe laryngeal involvement was decreasing, but this was merely a reflection of better handling and understanding of the original pulmonary disease.[3c] Real progress was made in the technic of collapse therapy, phrenicotomy and thoracoplasty. Earlier diagnoses plus better follow-up through the increasing use of roentgen rays and the enforcement of prolonged bed rest have reduced the incidence and severity of the disease. When laryngeal involvement was encountered, strict voice rest was enforced, and the use of only a pad of paper and a pencil was allowed.

Bronchoscopy has played an increasing role in the diagnosis and therapy of pulmonary tuberculosis. The interested endoscopist has shed much light on pathological changes in the tracheobronchial tree. Aspiration of the bronchi, dilation of tracheobronchial strictures, cauterization of granulation tissue and local instillation of medicines via the bronchoscope have become increasingly important in the management of tuberculous patients.

However, actual therapy for the laryngeal lesion itself had changed little since the turn of the twentieth century. Many authorities stated flatly that there was no satisfactory treatment for a large number of patients with tuberculosis. This was especially so when an "active" laryngeal lesion existed (as indicated by extreme pain, fever, hemoptysis, rapid weight loss, etc.). "Inactive" lesions were attacked somewhat more vigorously.

The accepted forms of treatment for tuberculous laryngitis were many and varied.[4] Such is the case when there exists no real satisfactory means of combating the disease.

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3. (*a*) Hulse, W. F.: Treatment of Tuberculosis of the Larynx, Arch. Otolaryng. **43**:578-585 (June) 1946. (*b*) Humphries, M. K. Jr.: Laryngeal Tuberculosis, Dis. of Chest **12**:129-146 (March-April) 1946. (*c*) Minor, C. L.: Laryngeal Tuberculosis from the Point of View of the Pulmonary Specialist, Ann. Otol., Rhin. & Laryng. **30**:870-887 (Dec.) 1921. (*d*) Edson, C. E.: Climate in the Treatment of Laryngeal Tuberculosis, ibid. **30**:888-897 (Dec.) 1921. (*e*) Dean, L. W.: The Treatment of Laryngeal Tuberculosis by Suspension Laryngoscopy, ibid. **30**:898-903 (Dec.) 1921. (*f*) Brown, L.: General Measures in the Treatment of Laryngeal Tuberculosis, ibid. **30**:904-911 (Dec.) 1921. (*g*) Levy, R.: The Surgical Treatment of Laryngeal Tuberculosis, Ann. Otol., Rhin. & Laryng. **30**:912-921 (Dec.) 1921. (*h*) Discussion on Symposium of Tuberculous Laryngitis, Tr. Am. Laryng. Soc. **43**:155-162, 1921. (*i*) Greene, J. B.: Prognosis in Laryngeal Tuberculosis, Arch. Otolaryng. **26**:18-28 (July) 1937.

4. Footnote 3*c*, *f* and *g*.

Treatment consisted of the following forms:

1. Local applications were used from the first and included various forms of silver, iodine, lactic and tannic acids, chaulmoogra and cod liver oils, various mentholated oils, guaiacol and related compounds. Such therapy plus cocaine applications certainly afforded some measure of palliation to the suffering patient.

2. Inhalations of volatile oils and counterirritants (phenol, thymol, eucalyptol and creosotes) were employed by various enthusiasts.

3. Physical therapy, including roentgen irradiation and diathermy, was reported to show good results.

4. Light therapy received much praise from its advocates, and all manner of elaborate apparatus were devised to direct the rays into the larynx. The sun's rays and artificial light both were recommended with much enthusiasm.

5. Chemotherapy in recent years has been used rather extensively.[5] Liquid sprays and actual powder insufflation of most of the sulfonamide drugs have been used. These have frequently been combined with parenteral medication. Recently nebulized penicillin plus the new drug glucosulfone sodium (Promin®) has resulted in some partial arrest of the disease.[6]

6. Surgical measures can best be listed under several subheads:

(*a*) Electrocauterization has enjoyed the most popularity of the older treatments, and with it uniformly better results have been obtained in experienced hands. Gruenwald[7] was one of the first to employ this technic. Albrecht and George B. Wood in this country[8] hold a prominent place in popularizing this method of treatment. Arrowsmith,[8d] Levy[8e] and Carmody[8f] and others have long since established this procedure as definitely indicated in certain types of cases. The electrocautery is used in three ways: (1) multiple puncture of edematous areas, (2) destruction of extensively diseased or irreparably damaged tissue and (3) searing of ulcerated areas with coagulating current. Properly used, the technic was the treatment of choice until the advent of streptomycin.

5. Myerson, M. C.: Sulfanilamide Spray for Pain in Tuberculous Laryngitis, J. A. M. A. **130**:1014-1015 (April 13) 1946.

6. Black, J. P. M.: Tuberculous Laryngitis: A Controlled Study, Am. Rev. Tuberc. **57**:409-411 (April) 1948.

7. Gruenwald, L.: Some Observations on the Treatment of Laryngeal Tuberculosis, J. Laryng. **20**:637-644, 1905.

8. (*a*) Wood, G. B.: The Actual Cautery in the Treatment of Localized Tuberculous Lesions, Ann. Otol., Rhin. & Laryng. **20**:531-535, 1911. (*b*) Wood, G. B.: The Use of the Electrocautery in Laryngeal Tuberculosis, Am. J. M. Sc. **163**:854-858 (June) 1922. (*c*) Wood, G. B.: Laryngeal Tuberculosis, Arch. Otolaryng. **8**:720-728 (Dec.) 1928. (*d*) Arrowsmith, H.: Present Day Aspects of Laryngeal Tuberculosis, New York M. J. **106**:245-248 (Aug.) 1917. (*e*) Levy, R.: Laryngeal Tuberculosis, J. A. M. A. **60**:1518-1523 (May 17) 1913. (*f*) Carmody, T. E.: The Treatment of Laryngeal Tuberculosis, Tr. Am. Laryng., Rhin. & Otol. Soc. **27**:274-279, 1921.

Even electrocauterization was not used in the so-called active pulmonary or laryngeal lesions, indicated by fever, excessive cough, dyspnea and pulmonary hemorrhage.

(*b*) Block of the superior laryngeal nerve or actual section of the nerve has given symptomatic relief, if the lesion is supplied by this nerve alone. Practically, this method has been reserved for intractable pain and has not been uniformly successful. Some authors have suggested block of the recurrent laryngeal nerve on the involved side when the lesion is small or of the glossopharyngeal nerve (on one side only so as not to impair swallowing) in desperate cases. Such measures are, of course, palliative and are not generally recommended.

(*c*) Epiglottidectomy, once highly praised and still practical, has no advantage over electrocauterization and may actually result in more trouble in swallowing.

(*d*) Laryngofissure, laryngectomy and curettement, once employed, serve no useful purpose and have been abandoned.

(*e*) Tracheotomy for the purpose of resting the larynx is basically unsound, as it is now known that the larynx is not really put at rest in this manner. The procedure may be weakening and harmful, except when employed as a life-saving measure after the tuberculous lesion becomes obstructing.

(*f*) Gastrostomy, purely a palliative procedure, is usually the beginning of the end. It is appalling how rapidly a patient goes downhill after a gastrostomy is done for the relief of dysphagia.

The reported incidence of laryngeal involvement in pulmonary tuberculosis varies with the observer and with the extent of pulmonary involvement. The larynx is infected in about 20 to 30 of the patients with the more advanced disease, but the percentage may be much higher (according to St. Clair Thomson [9]).

Much has been written about the pathway of spread of the tubercle bacillus from the lung to the larynx.[2a,b] The three possible means are by direct contact, by way of the lymphatic system and by way of the blood stream. It is beyond the scope of this paper to argue the merits of the various theories advanced, the most recent of which lean toward a lymphatic or hematogenous pathway. It would seem logical, however, not to discount the effect of trauma produced in coughing and the bringing-up of sputum. Once local tissue resistance breaks down at such a point of constant abuse, invasion of sputum-carried bacteria must surely take place.

Much of the literature concerning tuberculosis of the larynx deals at great length with the clinical appearance of the disease. Early and far advanced lesions are described and illustrated, and the various parts of the larynx involved are shown. This is all very well, but experience has shown conclusively that observation alone is insufficient. Chest roentgenograms and sputum studies are necessary for confirmation of the

9. Thomson, St. C.: Tuberculosis of the Larynx: Ten Years' Experience in a Sanatorium, Brit. M. J. **2**:841-844 (Nov. 8) 1924.

diagnosis. To eliminate the possibility of a coexisting lesion, blood serologic studies and even a microscopic analysis of the laryngeal lesions may be required.

When one has had an opportunity to follow a number of cases of laryngeal tuberculosis, a general pattern can be discerned.

Chronic hyperemia → { Ulceration → Necrosis-perichondritis
Edematous infiltration → proliferation

↓
Papilloma
↓
Tuberculoma
↓
Healing with fibrosis

Patchy, intense chronic hyperemia is the earliest sign of a beginning tuberculous involvement of the larynx. In a patient with poor resistance or in the presence of a virulent organism, this sign may rapidly be followed by ulceration and spread. Apparently trauma may be a factor in the very early lesion, as has been observed after bronchoscopy or severe coughing. At this stage, voice rest alone may result in healing if the pulmonary lesion is not out of control. When ulceration develops, it may frequently be observed first at the vocal processes, possibly associated with the involvement of one or both arytenoids.

The slower type of spread, resulting in an edematous infiltration of the laryngeal structures, produces a very pale, glistening mucosa and at its height may present the classic "turban-shaped" epiglottis. The proliferation of the laryngeal structures represents an effort of the structures toward healing by fibrous tissue formation. At any time, however, the process may revert to ulceration and necrosis. Extensive laryngeal necrosis produces pain partially by associated perichondritis and partially by open, infected ulcers in the mucosa.[9a]

The proliferative type of laryngeal lesion will frequently show the piling-up of the interarytenoid space to form a papilloma or tuberculoma. This type of lesion develops slowly, and there is a marked tendency toward healing with fibrous tissue formation. There is no substitute for constant and repeated laryngeal examinations to qualify the laryngologist to interpret the various phases of tuberculous involvement.

USE OF STREPTOMYCIN

With the cooperation of the staff of the local tuberculosis hospital, a study was undertaken to test the effect of streptomycin, given by several technics to a number of patients with proved laryngeal tuberculosis. This study was accomplished in most of the cases with the full assistance of the hospital personnel. Streptomycin was given both parenterally and by nebulizer to a total of 16 patients with far advanced pulmonary tuberculosis complicated by the laryngeal involvement.

9a. Eggston, A. A., and Wolff, D.: Histopathology of the Ear, Nose and Throat, Baltimore, Williams & Wilkins Company, 1947, pp. 916-920.

REPORT OF CASES

CASE 1.—I. B., a white woman aged 58, was first examined on June 21, 1946, because of pain on swallowing and weight loss. The patient was known to have pulmonary tuberculosis and only recently asked to be released from a local hospital. Laryngoscopic examination showed a markedly edematous and pale epiglottis with ulceration at the base on the laryngeal side. Both of the arytenoids and false cords were edematous and covered with a dirty slough. The true cords could not be seen, but motion was definitely limited. Available chest roentgenograms showed far advanced pulmonary tuberculosis with cavitation bilaterally. The sputum was positive for acid-fast bacilli. Kline and Kolmer blood reactions were negative. Streptomycin was not immediately available, and its administration was not started until Jan. 11, 1947. The dosage employed was 0.2 Gm. every three hours (1.6 Gm. in 24 hours). This dosage was used for one week, followed by a week of rest and then repeated. Thus eight weeks of treatment were given in 16 weeks. The patient was observed periodically during the treatment.

When therapy was started, on January 11, the patient was brought to the office on a stretcher, weak and almost unable to swallow her saliva. Pain was severe and the patient appeared doomed. On January 25, she was able to walk into the office for an examination. The whole picture had changed dramatically. Laryngoscopic examination showed much less edema of all laryngeal structures, and the ulcers were healing over. The larynx was generally much clearer. Observation on February 14, March 4 and April 25 showed continued resolution of the disease of the larynx with almost complete healing. Edema of the arytenoids and some piling-up of the interarytenoid space were the last to disappear. The patient has been followed for the last 16 months without showing the slightest tendency toward recurrence of laryngeal disease, although the sputum has remained positive and the chest roentgenogram has shown the chest condition to be about the same.

Comment.—This patient was one of the first treated with streptomycin in this area. The plan of a week's rest between each week's treatment was necessitated because of the scarcity of the drug at that time, but it has been postulated that this rest might actually have a tendency to prolong the development of bacterial strains resistant to the drug. Most dramatic was the relief of pain and dysphagia after about four days of therapy, and as a result there was a tremendous improvement in the patient's mental and physical outlook.

CASE 2.—R. B., a white man aged 61, was first examined Jan. 27, 1948, because of hoarseness and increasing pain on swallowing for the preceding three months. Kline and Kolmer reactions of the blood were negative. The sputum contained acid-fast bacilli. Chest roentgenograms showed far advanced pulmonary tuberculosis of the exudative type. Laryngoscopic examination revealed edematous and inflamed arytenoids with ulceration extending to both vocal processes. The interarytenoid space was ulcerated. Considerable granulation tissue had replaced the right false cord.

Treatment with streptomycin was given parenterally, 0.2 Gm. every three hours from January 28 to February 28. At this time there were dizziness and roaring of the ears, and an erythematous rash developed over the trunk and extremities. A four day rest was allowed during which the rash cleared completely. Dosage was continued, 0.25 Gm. four times a day from March 4 to March 16, without ill effects. The laryngeal lesion as seen in the illustration (fig. 1) showed good healing. It is noteworthy that the dysphagia and hoarseness had largely cleared in about one week of treatment. At the conclusion of treatment there was slight clearing of the chest roentgenogram, although the sputum was still positive for acid-fast bacilli.

Comment.—This patient showed the severest reaction to streptomycin of any of the patients studied. Caloric response became lost to 5 cc. of ice water. Hearing as shown by audiograms, was apparently unaffected, but the patient had already considerable loss in the high tones before administration of the drug was begun. The smaller dose of 1 Gm. of streptomycin a day was well tolerated after the rest period.

CASE 3.—C. R., a white man aged 30, was first examined Jan. 23, 1948, because of two months of hoarseness and increasing pain on swallowing. The patient was known to have tuberculosis and had been followed for two years in the tuberculosis

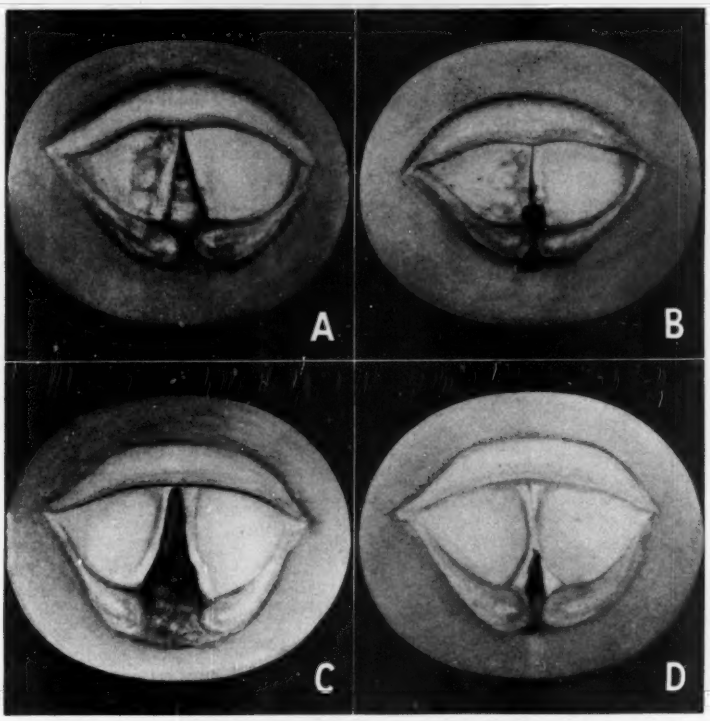

Fig. 1.—*A*, the tuberculous laryngeal lesion with the cords in abduction. Note the arytenoid cartilages are inflamed and both vocal processes involved. A considerable amount of granulation tissue is present on the right ventricular fold. *B*, same lesion as *A* but with the cords in adduction. One can readily see that both vocal processes are considerably involved. *C*, appearance of the larynx three weeks after the beginning of therapy. Most of the lesion has healed except for the interarytenoid space. *D*, same lesion as *B* but with the cords in adduction. The rounded niche on each vocal process represents healing of the destructive areas. Subsequently the niche of each cord rounded out some, lessening the hoarseness.

clinic. A chest roentgenogram showed far advanced tuberculosis, exudative in type. Kline and Kolmer reactions were negative. The sputum was positive for acid-fast bacilli. Laryngoscope examination showed extensive granulation tissue formation involving the arytenoids and interarytenoid space and extending laterally along the aryepiglottic folds. There was encroachment along the vocal cords only as far as the vocal processes (fig. 2).

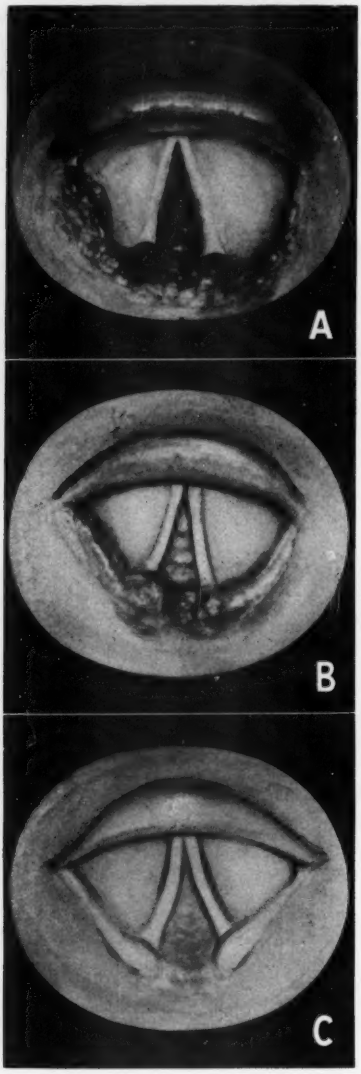

Fig. 2.—*A*, initial appearance of the lesion. A great amount of granulation tissue can be seen covering the arytenoid cartilages and interarytenoid space and extending along each aryepiglottic fold. *B*, after one week of therapy. Note the smoothing out of the granular masses. *C*, appearance after 3½ weeks of therapy. The larynx appeared healed, although therapy was continued almost one month longer.

Intramuscular administration of streptomycin was started; 0.2 Gm. was given every three hours (1.6 Gm. daily) on January 25 and administration was continued until March 2. Then because of severe dizziness and nausea a two day rest period was given. On March 4, the administration of 0.25 Gm. of streptomycin four times a day was started, and this dosage continued until March 13 without further side effects.

Comment.—As seen by the drawings (fig. 2), improvement began after about one week of therapy. Both hoarseness and dysphagia were relieved as the laryngeal involvement subsided. The vestibular complication occurred in the fifth week of treatment with loss of labyrinthine response to 5 cc. of ice water. The patient had some difficulty in arising or on sudden movement of the head thereafter, a condition which was present at the last examination on June 2. The sputum remained positive for acid-fast bacilli, and the chest roentgenogram did not show clearing at conclusion of the therapy. Again a smaller dose of streptomycin was well tolerated after a short rest period. This patient, as well as the patient discussed in case 2, has not had recurrence of laryngeal disease.

CASE 4.—S. U., a white man aged 39, was examined July 7, 1947, because of hoarseness and marked pain on swallowing. This had become marked in the three weeks prior to his initial examination. Exquisite pain was noted on swallowing any type of food. The serologic reaction was positive with Kline and Kolmer tests. The patient had been given a course of antisyphilitic therapy about a year previously. A chest roentgenogram showed far advanced pulmonary tuberculosis, largely exudative in type. The sputum was loaded with acid-fast bacilli. Examination showed the posterior part of the pharynx denuded of mucous membrane and presenting a grayish pseudomembrane. Laryngoscopic examination was rather difficult because of the pain. An ulcerated epiglottis, inflamed and edematous, concealed the anterior commissure of the larynx. Arytenoids were red and ulcerated bilaterally, the ulceration extending to the false cords and vocal processes. Streptomycin therapy was begun on September 19 with 1.0 Gm. a day in four doses. This was continued for 90 days and was discontinued December 19. Pain was relieved within a week of therapy, and hoarseness was about gone in one month of treatment. Examination of the larynx at the conclusion of therapy showed the posterior part of the pharynx well healed. Laryngoscopic examination showed a healed defect in the tip of the epiglottis. The epiglottis was pale, and the arytenoids were normal in size and color, as were the vocal cords. Movement of the cords was good. Sputum was positive. Roentgenograms showed some clearing of the pulmonary lesion.

Comment.—In cooperation with the medical staff of the local tuberculosis hospital, this patient was treated according to the 90 day program of 1.0 Gm. of streptomycin daily. This plan of using a small dose of streptomycin for 90 days is now part of a countrywide plan to determine the smallest effective dose of streptomycin that may be used.[10] There has been no recurrence of laryngeal symptoms in this patient. This patient had severe perceptive deafness and loss of caloric response initially, presumably because of syphilis.

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10. Hirsh, H. L.; Vivino, J. J., and Dowling, H. F.: Streptomycin, M. Ann. District of Columbia **17**:311-325 (June) 1948. Effect of Streptomycin Upon Pulmonary Tuberculosis: A Preliminary Report of a Cooperative Study of 223 Patients by Army, Navy and Veterans Administration, Am. Rev. Tuberc. **56**:485-605 (Dec.) 1947.

CASE 5.—V. M., a Negro man aged 32, was first examined on March 28, 1948, because of hoarseness and increasing difficulty in swallowing for six weeks previously. Chest roentgenograms revealed far advanced pulmonary tuberculosis with early cavitation. The sputum contained tubercle bacilli. Kline and Kolmer reactions were negative. Laryngoscopic examination revealed edematous arytenoids with piling-up and ulceration of the interarytenoid space (fig. 3). Some of the ulceration extended into the ventricles bilaterally. This man was given 1.0 Gm. of streptomycin daily, in four equal doses, for a period of 90 days. Pain was relieved in about four days, and hoarseness, though still present, is much less. Present examination shows healing of the larynx with some residual thickening of the vocal cords and interarytenoid space. Ulceration or exudate is not present. The sputum is still positive for organisms. Slight clearing of the chest can be noted in the roentgenogram.

Comment.—This is another case in which 1.0 Gm. of streptomycin was used daily for 90 days. Good laryngeal results were obtained. It is felt that minimal side effects are obtained with this dosage, and after 90 days most bacteria are probably streptomycin resistant. Some more

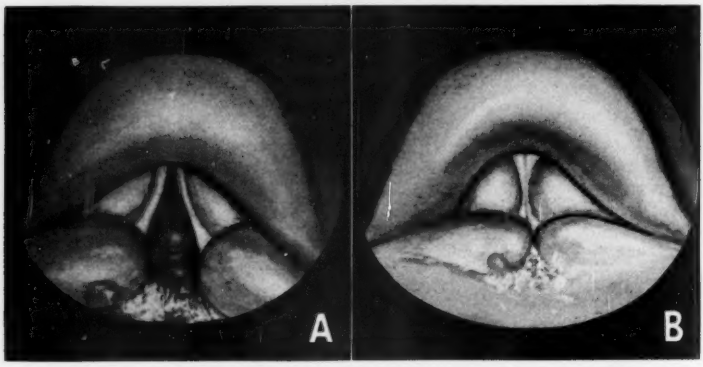

Fig. 3.—*A*, the lesion in abduction and *B*, the lesion in adduction. Note the swollen arytenoid cartilages and ulcerated interarytenoid space. Unfortunately follow-up illustrations were not made. One can readily see why there was marked dysphagia with this lesion.

recent patients are being given 0.5 Gm. of streptomycin daily for 60 days in an attempt to find the minimal effective dose for laryngeal tuberculosis.

CASE 6.—J. H., a white man aged 47, was first seen in what appeared to be a near terminal condition on Feb. 26, 1948. He was lying in a convalescent ward emaciated, listless and unable to swallow without extreme pain. He could speak only in a whisper from weakness and marked laryngeal involvement. He was a known tuberculous patient who had had pulmonary tuberculosis since 1942 and had not taken good care of himself. His present condition was the end result of a prolonged bout of alcoholic indulgence. His chest roentgenogram showed multiple cavity formation. Kline and Kolmer reactions were negative, and the sputum was positive for acid-fast bacilli.

Laryngoscopic examination showed a tremendously swollen and inflamed epiglottis and enlarged arytenoids, rendering a view of the cords difficult. Considerable ulceration was present at the base of the epiglottis and on the arytenoids. Because of the man's extremely uncooperative nature and resistance to "shots," he was given 1.0 Gm. of streptomycin daily but in two doses instead of four. The course of treatment extended for 90 days, from February 27 to May 27. Initial response was slower than usual. This man insisted on sitting in bed, using his voice inces-

santly and smoking 20 to 30 cigarets a day. However, at the end of the 90 days all ulcerations were healed. There was still some edema of the epiglottis, although the arytenoids were normal in size (fig. 4). There was no pain on swallowing, and the patient appeared definitely improved. Sputum was still positive, however, and there was no change in chest condition as shown by roentgenograms. Streptomycin therapy was stopped May 27. On July 11, the patient again began to complain of pain on swallowing and recurrent hoarseness. Examination of the larynx on July 17 showed a complete relapse of the laryngeal lesion to about the same picture as seen initially. An attempt was made to use nebulized streptomycin with 5 per cent sulfamylon® hydrochloride (paraaminomethylbenzenesulfonamide hydrochloride) but the patient was completely uncooperative for this procedure. Finally on July 24, with the patient appearing to go rapidly downhill, administration of 1.0 Gm. of streptomycin daily was again started, with 50,000 units of penicillin given four times daily. At the last examination, August 14, a slight decrease in pain and edema of the larynx could be noted, and the recurrent ulceration was smaller. The patient died October 15 from extension of the pulmonary lesion.

Comment.—This patient had a definite relapse of his laryngeal infection. It came on rather suddenly and reverted to the status of the initial condition. Some of the fault certainly lay with the patient himself, who had been resistant in every way to the proper management of a tuberculous patient.

CASE 7.—C. S., a Negro man aged 42, was a known tuberculous patient receiving institutional care for far advanced pulmonary tuberculosis. Because of increasing hoarseness of just under three months and some pain on swallowing, a laryngeal consultation was obtained on March 22, 1948. The larynx showed a moderate degree of ulceration of the posterior end of both true cords and some piling-up of the interarytenoid space. Sputum was positive. Kline and Kolmer blood reactions were positive, the patient having had some antisyphilitic therapy previously. Streptomycin therapy, 1.0 Gm. daily in four divided doses, was started April 4 and finished on July 4. About 10 days after therapy was begun all pain was relieved, though some hoarseness has persisted to the present. The sputum remained positive. Little change in the chest roentgenogram was noted. Laryngeal examination at the conclusion of therapy showed some residual thickening of the vocal cords. There was no ulceration and no injection. The larynx appeared healed.

Comment.—This patient also showed a satisfactory response to a small dose of streptomycin for 90 days. The only ill effect noted was some transient unsteadiness, first complained of about four weeks after the beginning of therapy. Caloric response to 5 cc. of ice water was diminished. The unsteadiness was not complained of at the conclusion of therapy, but the labyrinthine response remained only slightly responsive to 5 cc. of ice water.

CASE 8.—R. R., a Mexican man aged 42, was admitted for sanatorium care in July 1947 because of far advanced pulmonary tuberculosis. Chest roentgenograms revealed an extensive pulmonary lesion with cavitation of the right lung. Sputum was positive. Kolmer and Kline blood reactions were positive. Because of hoarseness, a laryngological consultation was requested. In August, the larynx presented an edematous, pale epiglottis, large and overhanging. Several roughened ulcerated areas were present on the epiglottis. Both cords were smooth but inflamed and somewhat edematous. This condition was maintained until administration of streptomycin was started on January 23. It was given in doses of 1.0 Gm. daily (0.25 Gm. four times daily) until April 26. A slight residual hoarseness prevailed. Laryngeal examination at the conclusion of therapy showed no ulceration or inflammation. The epiglottis was pale and thin. The cords were still a little thick,

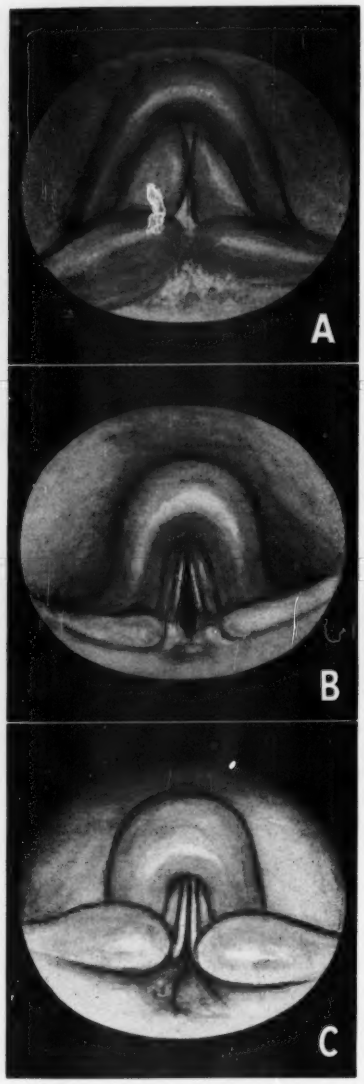

Fig. 4.—*A*, note the edema of the epiglottis, ventricular folds and arytenoid cartilages even after 13 days of therapy. Because of the pain this was as soon as an illustration could be properly made. Ulcerations are still present in the interarytenoid space. *B*, edema of the epiglottis is still present at the conclusion of therapy, although arytenoids, ventricular folds and interarytenoid space appear healed. The patient did not have pain at this stage. *C*, relapse with the return of edema of the arytenoid cartilages. Piling-up of the interarytenoid space associated with tiny ulcerations (not well seen) is present.

and there was some residual piling-up of the interarytenoid space. The lesion appeared inactive.

Comment.—This patient, too, showed a good laryngeal response to 1.0 Gm. of streptomycin daily for 90 days. Again, however, the sputum did not clear and continued to show acid-fast bacilli. The chest roentgenogram showed no change except for a questionable clearing of the left lung.

CASE 9.—N. J., aged 65, was seen initially by his local physician in November 1944 because of hoarseness of 3½ months' duration. A biopsy specimen of the larynx taken at that time showed what was said to show a very early grade I carcinoma. On November 17, laryngofissure was performed, and the left cord was destroyed by electrocauterization. Hoarseness persisted, and apparently the larynx continued to look suspicious, because two subsequent specimens for biopsy were taken by the patient's physician. On August 24, the first laryngeal biopsy specimen was reported as showing "connective tissue which contains inflammatory cells."

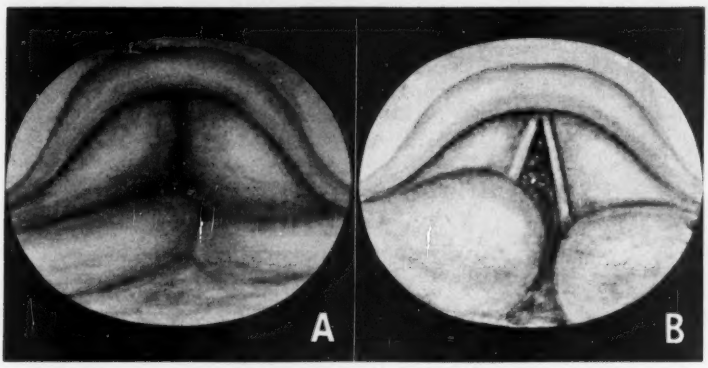

Fig. 5.—*A*, appearance of the larynx just before tracheotomy. Note the tremendous edema of all laryngeal structures and practically complete lack of airway. Definite ulcerations could not be seen. The patient did not have any pain. *B*, after two months of therapy. Eventually, even the swollen arytenoid cartilages returned to normal size.

On January 4, the second biopsy specimen was reported as showing "chronic granulomatous inflammation, possibly tuberculous." Still no chest roentgenogram or sputum examination was made! Because of increasing dyspnea, hoarseness and weight loss, I was called to examine the patient on April 5. Tremendous swelling of the epiglottis, ventricular folds and arytenoids necessitated an immediate tracheotomy (April 6). At the time of the tracheotomy, a specimen of the laryngeal lesion was taken for microscopic study. Sputum studies showed many acid-fast bacilli. A chest roentgenogram showed far advanced tuberculosis with some cavitation bilaterally. Serologic reactions were negative for syphilis. The pathologist reported that the laryngeal tissue showed typical tubercles.

The patient was immediately given 1.0 Gm. of streptomycin a day in four divided doses (beginning April 7). In one month, a great deal of the laryngeal edema had subsided. Both cords could be readily seen, and both moved. Ulceration was not present. At the end of two months of therapy only a slight residual edema of the arytenoids persisted (fig. 5). Movements of the cords were about normal, and

the voice was of fair quality. On July 7, the streptomycin was discontinued and the tracheotomy tube removed. A plastic closure was made of the tracheostoma on July 31. Chest roentgenogram showed the chest condition to be unchanged, and the sputum is still positive. The laryngeal lesion is now quite inactive.

Comment.—This highly instructive case presents many features that could be discussed. Poor handling of this patient greatly aggravated the disease and undoubtedly helped to disseminate the tubercle bacillus. Certainly any doubtful laryngeal lesion merits a chest roentgenogram, a blood serum test, possibly a biopsy, and sputum studies every time. The lack of pain must be attributed to the absence of sizable ulcerations. The larynx in this case became edematous and laid down fibrous tissue in an effort to combat the infection. The response to streptomycin was a beautiful thing to see. Incidentally, this patient was cared for in his home with the intelligent administrations of his well trained wife.

CASE 10.—L. S., a Negro woman aged 28, was examined March 27, 1948, because of two months' hoarseness and a persistent sore throat. Solid foods had been quite painful to swallow for about one month. A chest roentgenogram showed a far advanced pulmonary lesion with cavitation. The sputum was positive for acid-fast organisms. Kline and Kolmer reactions of the blood were negative for syphilis. Laryngoscopic examination showed a granulomatous mass at the base of the epiglottis, covered with exudate. There was edema of the false cords, true cords and arytenoids, with some ulceration of the arytenoids and the interarytenoid space.

On June 3, inhalation of streptomycin with 5 per cent sulfamylon® was begun. One hundred cubic centimeters of 5 per cent sulfamylon® hydrochloride was used to dissolve 20,000 units of streptomycin. Then 10 cc. of the resulting solution was inhaled by the patient four times daily. Thus 200 units of streptomycin in 1 cc. was obtained for inhalation. This amount has been shown to be effective in vitro, and, in fact, a stronger solution tends to precipitate and clog the nebulizer. Pain was relieved in about three days. The laryngeal picture improved so that on June 12 (nine days after the beginning of the inhalations) exudate was not present, and the ulcerations were rather shallow and appeared clean. Less edema of all laryngeal structures was noted. On July 12, all ulcers had disappeared. There was still roughening of the cords and injection of the larynx. On August 5, inhalations were stopped. The patient had no pain and raised less sputum. Except for a moderate erythema (which cleared several days after the inhalations were stopped), a definite laryngeal healing had occurred (fig. 6). The sputum was still positive for acid-fast bacilli. The chest roentgenogram showed that the chest condition was unchanged.

Comment.—No side effects, even vestibular, were noted with the 5 per cent sulfamylon® hydrochloride–streptomycin inhalations. This method was used in an effort to compare the action on the larynx of streptomycin administered locally with that administered parenterally. Sulfamylon® hydrochloride was added to attack that portion of secondary bacterial invaders not affected by streptomycin.[11] It was felt, too, that the addition of another drug slows down the speed with which resistant strains of acid-fast bacilli are produced. The taking of four inhalations daily of 10 cc. of the solution did not generally prove too

11. Howes, E. L.: Prevention of Wound Infection by the Injection of Non-Toxic Anti-Bacterial Substances, Ann. Surg. **124**:268-276 (Aug.) 1946. Howes, E. L.: Topical Use of Streptomycin in Wounds, Am. J. Med. **2**:449-456 (May) 1947.

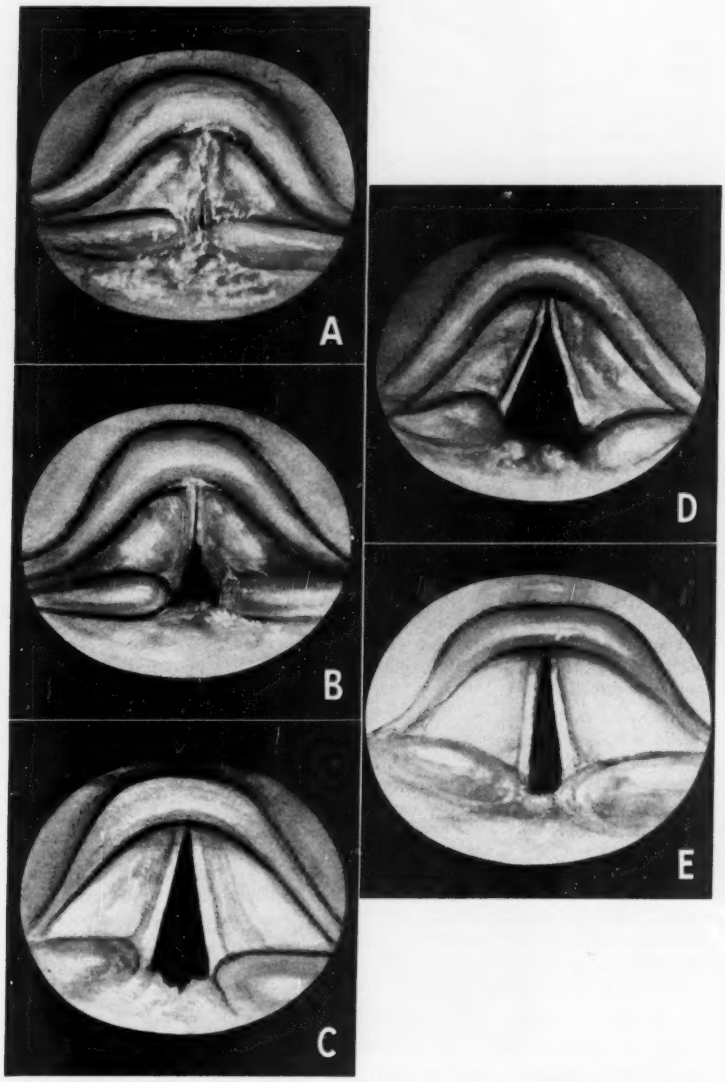

Fig. 6.—*A* and *B*, the initial lesion in adduction and partial abduction. Note the granular, ulcerative lesion. *C*, *D* and *E*, various stages of healing after inhalation of nebulized 5 per cent sulfamylon® hydrochloride–streptomycin. *E*, lesion apparently healed after 60 days of therapy.

much of a task for the patient. No other therapy except bed rest was employed.

Case 11.—M. M., a Mexican woman aged 36, was receiving sanatorium care, having been admitted with far advanced pulmonary tuberculosis in August 1947. When first seen by the laryngologist, on May 1, 1948, the patient complained of soreness of the right side of the throat of three months' duration, aggravated by swallowing. The patient had a positive sputum. The Kline and Kolmer reactions were negative. There were cavities in each lung, especially in the right lung, for which a pneumothorax was induced April 15. Laryngoscopic examination showed a punched-out ulcer involving the right vocal process and extending to the right arytenoid. There was a surrounding zone of erythema. Sulfamylon® 5 per cent hydrochloride–streptomycin inhalation was commenced May 13. On May 22, there was less discomfort, and the ulcer was smaller and cleaner. On June 5, the ulcer had healed with a shallow depression remaining (fig. 7). Inhalation was discontinued on July 15. The larynx has remained healed to the present time (August 15). The roentgen picture did not show change, and the sputum remained positive.

Comment.—This was a small lesion that healed rather well with the nebulized 5 per cent sulfamylon® hydrochloride–streptomycin. No change in caloric response occurred; it was normal and active throughout the treatment. No other side effects were noted.

Case 12.—L. B., a white woman aged 62, was hospitalized in July 1947 because of far advanced pulmonary tuberculosis. The sputum was positive for acid-fast bacilli. The Kline and Kolmer reactions were negative. A chest roentgenogram revealed a fibrotic type of tuberculosis with cavity formation. A laryngological consultation was first obtained on April 28, 1949, because of a persistent sore throat of six weeks' duration. This soreness was aggravated by swallowing and coughing. There was also increasing hoarseness. Laryngeal examination showed an edematous left arytenoid, which was inflamed and ulcerated. The ulcerative process extended to the interarytenoid space and partially involved the left vocal process and left ventricular fold.

It was felt that the fibrotic type of pulmonary tuberculosis with cavitation would not show the best results if treated with streptomycin parenterally, and, accordingly, on May 10, 5 per cent sulfamylon® hydrochloride–streptomycin inhalation was started. No particular improvement was noted for about one month. In fact, the medication appeared to cause a generalized laryngeal erythema, cough and increase in sputum for a number of days, but therapy was persistently continued, and about June 12 the ulceration was seen to be clearing up. It is interesting to note that the pain and discomfort were relieved after only about a week of therapy, a fact that held true in all cases in which the nebulized streptomycin was used. Inhalation was discontinued July 24. The larynx was clean without exudate, although edema of the left arytenoid and erythema still persisted. At the last examination, on August 5, much of the erythema had left. A small healed defect at the site of the left vocal process marked the end result of the disease (fig. 8).

Comment.—It was felt that the nebulized medicine was an irritating factor in this case, and for a time there was some question as to whether or not the therapy could be continued. However, since the pain and discomfort in eating had been relieved, the medication was continued, and after about four weeks the patient was able to tolerate the inhalations without difficulty.

Case 13.—L. R., a Mexican man aged 45, entered the sanatorium in July 1947 with far advanced pulmonary tuberculosis of the exudative type. The sputum was

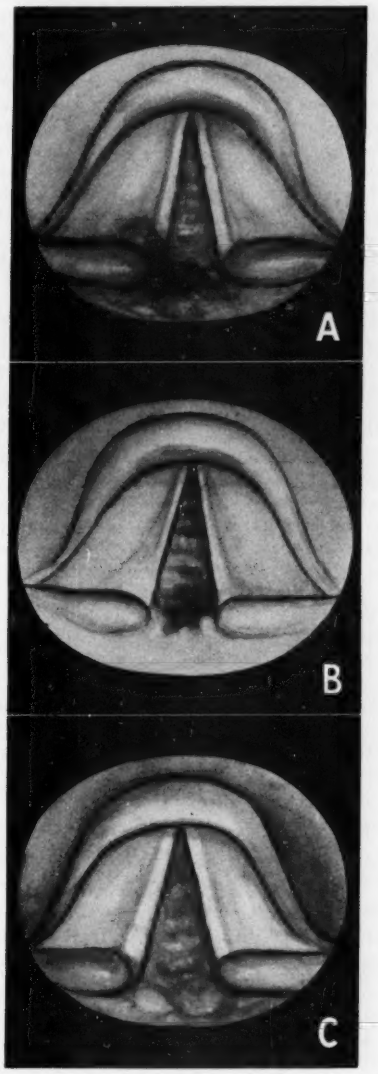

Fig. 7.—*A*, initial lesion, a granular, ulcerative mass of the interarytenoid space and right arytenoid cartilage, extending to the right vocal process. *B*, after three weeks of treatment with nebulized 5 per cent sulfamylon® hydrochloride–streptomycin. There is still a roughened granular area in the interarytenoid space, although the right arytenoid cartilage and right vocal process appear healed. The patient was now asymptomatic. *C*, healed laryngeal lesion three weeks after therapy was discontinued.

positive for acid-fast bacilli. The Kline and Kolmer reactions were negative. Laryngeal examination at the time revealed edematous and inflamed arytenoids with piling-up and early ulceration of the interarytenoid space. The patient had no pain but did complain of hoarseness. Streptomycin, 1.0 Gm. daily, was given in four divided doses from September 1 to November 30. The edema subsided, and the hoarseness cleared. The laryngeal disease then appeared inactive. A reexamination of the larynx was made June 5, 1948, because of increasing hoarseness of several weeks' duration. A tuberculoma was discovered just medial to the left arytenoid about 1 cm. in diameter at the base and about 2 cm. high. Ulceration was not present. On June 6, 5 per cent sulfamylon® hydrochloride–streptomycin inhalations were begun. By July 12, the tuberculoma was definitely smaller, and it was quite small on August 12, when the inhalations were discontinued (fig. 9). The sputum remained positive for acid-fast bacilli in spite of treatment with the parenteral and nebulized streptomycin.

Comment.—It was interesting to note that recurrent tuberculous laryngitis, at least of the proliferative type, would respond to local streptomycin treatment after a prolonged course of streptomycin administered parenterally. No ill effect of any kind was noted from the nebulized medicine. Hoarseness is still present but in mild degree.

CASE 14.—L. C., a white man aged 40, had previously been hospitalized for pulmonary tuberculosis. However, in August 1947, he signed out against advice and was not seen again until June 25, 1948. At that time he consulted an otolaryngologist because of increasing hoarseness and extreme pain on swallowing of one month's duration. Both arytenoids were swollen and ulcerated with denuded areas extending to each vocal process. Some edema of the base of the epiglottis was also present. Sputum was positive for acid-fast bacilli. Kline and Kolmer reactions were negative. A chest roentgenogram showed a fibrocaseous tuberculosis with cavitation.

Inhalations of 5 per cent sulfamylon® hydrochloride–streptomycin were begun June 24. Within two days the patient could eat without difficulty. In one month all the edema of the larynx was gone, although there were shallow ulcerations on each vocal process surrounded by a zone of erythema. At the last examination, Aug. 12, 1948, two tiny ulcerated areas were still present over each vocal process and were apparently decreasing in size. Therapy was to be continued for a course of 60 days. The results of subsequent sputum studies remained positive.

Comment.—This patient is still being treated, but one may say that the results to date have been good. The patient is able to eat any kind of food without difficulty and has gained about 12 pounds (5.4 Kg.) in weight. It is interesting to note how soon relief of pain follows the initiation of therapy. Incidentally, this patient was treated as an outpatient quite satisfactorily.

CASE 15.—D. S., a white woman aged 40, complained of hoarseness following bronchoscopy. She had been hospitalized because of far advanced pulmonary tuberculosis in the summer of 1947. Roentgenograms revealed fibrocaseous tuberculosis with a large cavity at the apex of the left lung. The results of sputum studies were positive for acid-fast bacilli. Kline and Kolmer reactions were negative. Bronchoscopy was performed May 30, 1948, without difficulty, but a persistent hoarseness necessitated a laryngological consultation. Laryngeal examination revealed a bright erythema of the left true cord with a tiny ulceration at the base of the left vocal process. The rest of the larynx was entirely normal, and the laryngeal movement was normal. The patient did not complain of pain but felt an occasional "sticking sensation" in the left side of the throat. As the laryngeal picture remained unchanged in spite of voice rest for six weeks following the bronchoscopy, 5 per

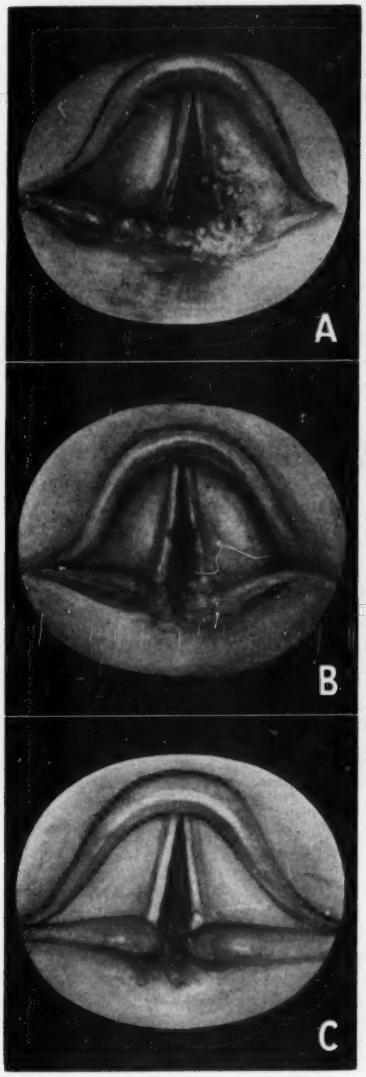

Fig. 8.—*A*, initial lesion involving the left arytenoid cartilage and extending across the interarytenoid space and along the left false and true cords. The lesion was granular and ulcerated and associated with considerable pain. *B*, after three weeks of inhaling nebulized 5 per cent sulfamylon® hydrochloride–streptomycin. Granulation tissue is still present but decreasing. The patient still had some occasional pain. *C*, three weeks after therapy was discontinued. Note the healed defect in the right vocal process. The interarytenoid space, though injected, was considerably less inflamed since inhalations had been stopped. The patient was asymptomatic.

cent sulfamylon® hydrochloride–streptomycin inhalation was started July 19. One week later, July 26, the hoarseness was unchanged but the erythema was less, and the tiny ulceration appeared as a healed niche. At last examination, August 12, there was only a slight pinkish color to the left cord as compared with the right cord (fig. 10). The results of recent sputum tests are not available, since inhalation was started.

Comment.—This patient is still in the process of receiving therapy, but definite improvement can be noted. Incidentally, this type of laryngeal involvement with tuberculosis is the very earliest that can be seen clinically. The bright chronic erythema, sometimes diffuse, sometimes in patches, precedes the ulcerative and proliferative stages of the disease. Such a stage usually will not cause the patient to come to the physician but is detected in any institution where frequent and careful attention is given to the larynx. Trauma may have precipitated the lesion discussed above, although it is more likely coincidental. Of interest is the fact that voice rest for a six week period was without avail.

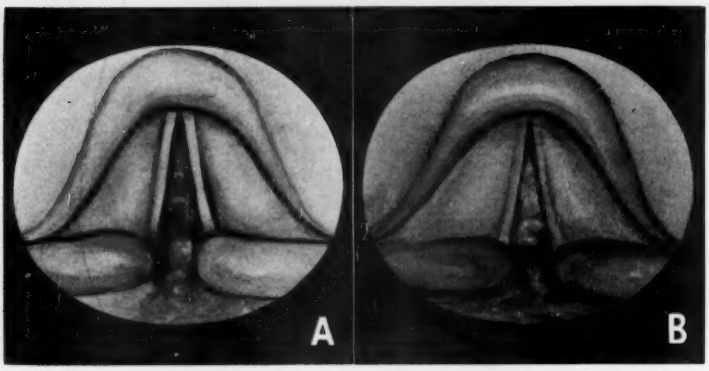

Fig. 9.—*A*, initial appearance of lesion. Note the tuberculoma before administration of nebulized 5 per cent sulfamylon® hydrochloride–streptomycin was started. *B*, at the conclusion of therapy. Note definite decrease in size of tuberculoma.

Case 16.—T. A., a white man aged 58, was admitted to the sanatorium on June 1, 1948, markedly emaciated, febrile and extremely weak. Hoarseness had been present for three weeks. There had been recent twinges of pain in the left ear. A chest roentgenogram showed both lungs riddled with cavities. Sputum was positive for acid-fast bacilli. Kline and Kolmer reactions were negative. Laryngoscopic examination showed a dirty ulcer on the tip of the epiglottis. Both arytenoids were a little swollen. The right cord was roughened and contained several ulcers, especially in the region of the vocal process (fig. 11). Treatment with 5 per cent sulfamylon® hydrochloride–streptomycin was begun June 2. For about three weeks the laryngeal lesions cleared up, and this patient could swallow with less difficulty. However, about July 1 the patient was obviously growing weaker, and by July 12 could use the nebulizer only with difficulty. The patient died July 23.

Comment.—The larynx had been examined three days before death, and some extension of the lesion of the epiglottis and the right vocal cord was noted, but at autopsy it was amazing to see the extent to which the terminal disease had spread. Most of the mucosa of the larynx was destroyed, including both vocal cords. The destruction extended

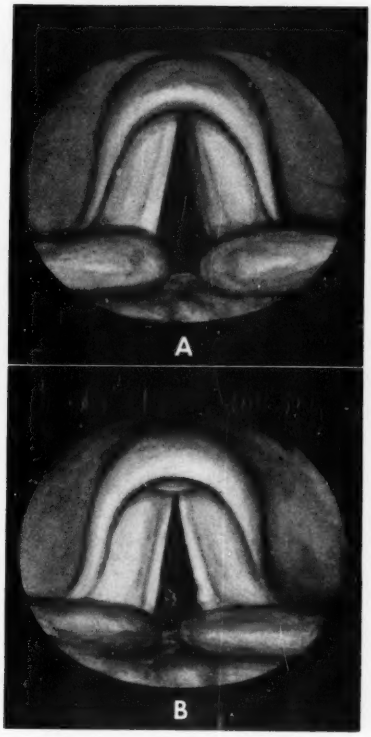

Fig. 10.—*A*, initial lesion. Note intense hyperemia of the left vocal cord and small niche at the left vocal process. *B*, after two and a half weeks of inhaling nebulized 5 per cent sulfamylon® hydrochloride–streptomycin. A defect of the left vocal process can be noted, although the lesion appears inactive. Plan is to continue therapy for a total of 60 days.

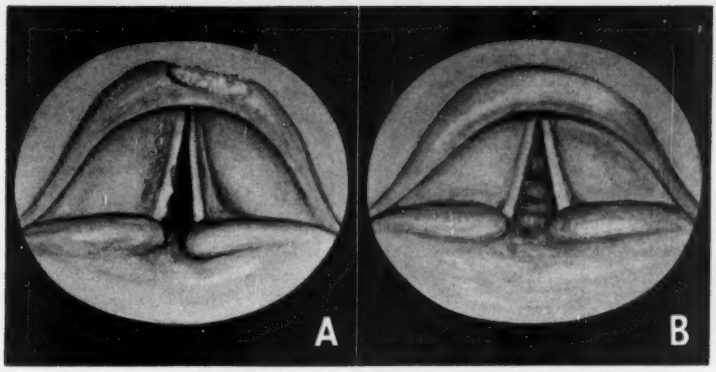

Fig. 11.—*A*, initial lesion with a dirty ulcer of the epiglottis and a roughened and ulcerated right vocal cord. *B*, after 26 days of treatment with nebulized 5 per cent sulfamylon® hydrochloride-streptomycin. The larynx appeared well on the way to recovery, but within the next week the patient's pulmonary status deteriorated and the patient died July 23, 1948.

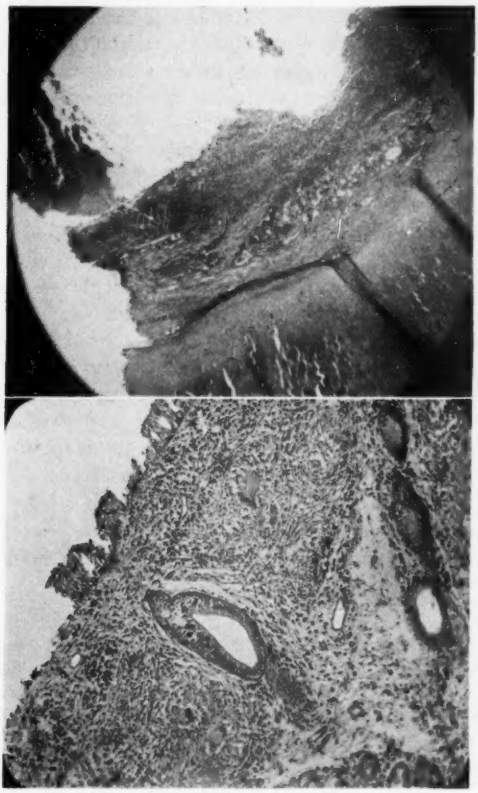

Fig. 12 (case 16).—Tissue from larynx. Note denuded epithelium and tuberculous granulation tissue extending almost to the laryngeal cartilage. These changes occurred during the last few days before death.

to the cartilages on the right side (fig. 12). It has been observed that patients with terminal laryngeal tuberculosis undergo a massive spread of the disease with great destruction of tissue shortly before death.[2a, b] Such was the case here.

It was felt that the 5 per cent sulfamylon* hydrochloride-streptomycin was exerting a beneficial effect on the laryngeal lesion but was unable to cope with the pulmonary disease. With increasing weakness, the patient had been unable to exert enough energy to keep taking his inhalations.

COMMENT

In the foregoing report of cases, some of the newer technics in the treatment of laryngeal tuberculosis were presented in an effort to determine the most satisfactory method of using streptomycin. The first three patients (cases 1, 2 and 3) were given the larger doses of streptomycin, 0.2 Gm. every three hours. In the first case, owing to the shortage of streptomycin at that time, one week of treatment was alternated with one week of rest for a total of eight weeks of therapy over a period of 16 weeks. It is certainly to be regretted that facilities were not available to test the development of streptomycin-resistant strains of acid-fast bacilli in this case, as there is reason to believe that alternating treatments, one week on and one week off, delay development of the resistant strains.

In all three patients definite labyrinthine disturbances were noted subjectively and objectively, although the disturbances were not so severe in the first case. Loss of caloric response to 5 cc. of ice water had occurred in all three cases as noted in the table. The most severe reaction, including an erythematous skin rash, occurred with the second patient (case 2). However, after four days' rest the rash cleared and a smaller dose of the drug was well tolerated.

Six patients (cases 4 through 9) were given the much smaller dose of streptomycin, 1.0 Gm. daily in either two or four divided doses for 90 days. This was in accordance with a plan that is now being rather generally tried over the country to determine the smallest effective dose of streptomycin. It appears quite likely that two thirds to one half of this dose may eventually be effective in some cases of laryngeal tuberculosis, although it is still too soon for results to be certain.[13]

There are still relapses in about one fifth of the reported patients treated, as was seen in case 6. Whether a second course of streptomycin

12. Footnote deleted.

13. Streptomycin, editorial, Am. J. Med. **2**:419-420 (May) 1947. Herrell, W. E., and Heilman, F. R.: Streptomycin, Am. J. Med. **2**:421-428 (May) 1947. Hinshaw, H. C.; Pyle, M. M., and Feldman, W. H.: Streptomycin in Tuberculosis, Am. J. Med. **2**:429-434 (May) 1947. Report on Streptomycin in Tuberculosis, Committee on Chemotherapy and Allied Measures, Dis. of Chest **13**:169-170 (March-April) 1947. Kincade, G. F.; Soxton, G. D.; Moore, P. W., and Mathisen, A. K.: Streptomycin in the Treatment of Tuberculosis, Canad. M. A. J. **59**:105-112 (Aug.) 1948. Walls, W. L., and Moyer, R.: Streptomycin in the Treatment of Draining Tuberculous Sinuses, Virginia M. Monthly **75**:389-394 (Aug.) 1948. Hinshaw, H. C.; Feldman, W. H., and Pfuetze, K. H.: Treatment of Tuberculosis with Streptomycin: A Summary of Observations of 100 Cases, J. A. M. A. **132**:778-782 (Nov. 30) 1946.

Summary of Data on Streptomycin Therapy for Laryngeal Tuberculosis

Case No.	Age	Serologic Reactions *	Sputum	Method of Streptomycin Administration	Reactions	Caloric Response (5 Cc. of Ice Water)	Chest Roentgenogram at End of Treatment
1	58	—	+	0.2 Gm. q. 3 hr. alternate weeks 1/11-4/25/47	No complaints or discomfort	Loss of response	Far advanced pulmonary tuberculosis with cavitation; unchanged
2	61	—	+	0.2 Gm. q. 3 hr. 1/28-2/28/48; 0.25 Gm. q. i. d. 3/4-3/16/48	2/20 vertigo and slight deafness; 2/28 intense ringing of ears and erythematous rash	Loss of response	Far advanced pulmonary tuberculosis, exudative type; slight clearing
3	30	—	+	0.2 Gm. q. 3 hr. 1/25-3/2/48; 0.25 Gm. q. i. d. 3/4-3/13/48	3/2 severe vertigo, slight tinnitus, nausea	Loss of response	Far advanced pulmonary tuberculosis, exudative type; unchanged
4	39	+	+	0.25 Gm. q. i. d. 9/19-12/19/47	No symptoms	Loss of response present initially	Far advanced pulmonary tuberculosis, exudative type; some clearing
5	41	—	+	0.25 Gm. q. i. d. 3/1-6/1/48	No symptoms	Diminished	Far advanced pulmonary tuberculosis with early cavitation; some clearing
6	47	—	+	0.5 Gm. b. i. d. 3/5-6/5/48	4/15 slight dizziness	Diminished	Far advanced pulmonary tuberculosis with multiple cavity formation; no change
7	42	+	+	0.25 Gm. q. i. d. 4/4-7/4/48	5/5 unsteadiness	Diminished	Far advanced pulmonary tuberculosis with cavitation; little change
8	43	+	+	0.25 Gm. q. i. d. 1/23-4/26/48	No symptoms	Unchanged	Far advanced pulmonary tuberculosis with cavitation on right; questionable clearing of left lung
9	65	—	+	0.25 Gm. q. i. d. 4/22-7/22/48	No symptoms	Unchanged	Far advanced pulmonary tuberculosis with cavitation bilaterally; no change
10	28	—	+	Combined † 6/3-8/5/48	No symptoms	Unchanged	Far advanced pulmonary tuberculosis with cavitation; no change
11	26	—	+	Combined † 5/13-7/13/48	No symptoms	Unchanged	Far advanced pulmonary tuberculosis with cavitation especially on right; no change
12	62	—	+	Combined † 5/10-7/24/48	Increase of sputum and cough, first 3 wk. of therapy	Unchanged	Far advanced pulmonary tuberculosis, fibrotic type, with cavitation; no change
13	45	—	+	0.25 Gm. q. i. d. 9/1-11/30/47; combined † 6/6-8/5/48	No symptoms	Diminished	Far advanced pulmonary tuberculosis, exudative type; some clearing
14	40	—	+	Combined † 6/24-8/24/48	No symptoms	Unchanged	Fibrocaseous tuberculosis; no follow-up as yet
15	40	—	+	Combined † 7/19-9/19/48	No symptoms	Unchanged	Fibrocaseous tuberculosis with cavitation; no follow-up
16	58	—	+	Combined † 6/2-7/12/48	Increasing weakness; after 7/12 inability to use nebulizer; died 7/23	Unchanged	Far advanced pulmonary tuberculosis with cavitation bilaterally

* Kline and Kolmer reactions of the blood.
† Five per cent sulfamylon and streptomycin (200 units per cubic centimeter).

will be effective is not certain but definitely worth investigation, as a large number of susceptible acid-fast bacilli may still be present. The second course of streptomycin may well be combined with penicillin or one of the sulfonamide drugs to render the bacteria more susceptible or slower in developing resistant strains.

Seven patients (cases 10 through 16) were treated in an effort to compare the effect of nebulized streptomycin with that of streptomycin given parenterally. At first patients were selected who had fibrocaseous pulmonary involvement with cavitation, for which streptomycin administered parenterally has been rather ineffective.

One hundred cubic centimeters of 5 per cent sulfamylon® hydrochloride was mixed with 20,000 units of streptomycin so that each cubic centimeter of sulfamylon® contained 200 units of streptomycin. It was found that a patient could inhale 10 cc. of this mixture four times a day without too much difficulty, thus inhaling 8,000 units of streptomycin daily. Reports are now available to show that when streptomycin is used locally for mixed infections, it does not have a complete bacterial spectrum at its proper concentrations, and some susceptible bacteria rapidly acquire a resistance to streptomycin alone.[11] Five per cent sulfamylon® hydrochloride, because of its stability, makes a better combination with streptomycin than with penicillin. Sulfamylon® hydrochloride has a wider bacterial spectrum than penicillin and acts rapidly in the presence of pus. Hence, to combat the mixed bacterial flora of the larynx, the mixture of 5 per cent sulfamylon® hydrochloride–streptomycin was inhaled by the patient for approximately 60 days.

As noted in the table, there was occasional loss of caloric response with streptomycin inhalation, and, when carefully questioned, some of the patients replied that they had noted occasional disturbance on sudden movements of the head. One patient (case 12) apparently was irritated by the nebulized medicines which may have delayed healing. However, the generalized erythema cleared after completion of the course, and lasting untoward results were not observed.

Case 13 supports the view that nebulized streptomycin apparently has some effect directly on the larynx even after the patient has had the 90 day course of streptomycin administered parenterally and yet still shows activity or recurrence of the laryngeal disease. Treatment in case 14 was carried out in the home and was just as effective as that of the hospitalized patients. With the bed situation as critical as it is today, treatment at home offers an easy way to commence therapy without the patient having to wait for hospitalization. The fifteenth and sixteenth patients (cases 15 and 16) show the contrast between the effect of nebulized streptomycin on a very early laryngeal lesion with the effect on an advanced laryngeal lesion with a terminal pulmonary condition. Attempt at healing did occur even in the terminal case, but the disease was incurable.

SUMMARY AND CONCLUSIONS

Waksman, Bugie and Schatz [14] have placed in the clinician's hand a tool which is proving effective against acute exudative pulmonary tuberculosis, and especially the troublesome laryngeal complication of pulmonary tuberculosis. Sixteen patients with tuberculosis of the lungs with laryngeal involvement have been treated parenterally according to several dosage plans and by the aerosol technic.

Streptomycin in each case proved an effective agent so far as the laryngeal status was concerned. In the patients with exudative pulmonary tuberculosis some clearing could be noted on the roentgenogram, but in no patients of this group did the sputum become negative. This demonstrates well the bacteriostatic action of streptomycin, which holds the acid-fast bacteria in check while its remarkable action on granulation tissue formation allows healing to take place. The effect of streptomycin on granulation tissue formation of the larynx resulting from moniliasis has been noted.[15] From this series of patients studied, it may be said that parenteral administration of streptomycin is the more effective method of administering the drug but carries the greater risk of side reactions.[16]

The 5 per cent sulfamylon® hydrochloride–streptomycin acts considerably more slowly than streptomycin given parenterally. Side reactions are very slight, if they occur at all. This has proved a very pleasant way of administering this medicine. It is doubtful that the inhalation of 5 per cent sulfamylon® hydrochloride–streptomycin exerts any influence on the pulmonary lesion. Thus, parenteral administration of streptomycin remains the method of choice. A laryngeal lesion may readily heal although the sputum remains positive and the chest condition unchanged.

The single outstanding feature of streptomycin medication, regardless of the method by which it is given, is the relief of pain in the larynx when this organ is involved. Such relief is soon followed by an adequate intake of nourishment and a most encouraging boost to the patient's morale—measures of great importance in any chronic illness.

At the risk of pointing out the obvious, it must be emphasized that teamwork between the internist treating pulmonary tuberculosis and the

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interested laryngologist is necessary for proper handling of laryngeal tuberculosis. When any new drug is being used, minute changes in the various parts of the body must be observed and recorded by those best qualified to do so. Then adequate doses can be determined with minimal damage produced. The relation between the laryngeal and the pulmonary form of tuberculosis is so intimate that neglect of either condition aggravates the other. Further, a laryngeal lesion may heal in the presence of continued pulmonary tuberculous activity, but the status of the lungs will never improve while there is active tuberculous laryngitis.

Finally, it must be acknowledged that cure is not accomplished in all cases, even with streptomycin. More study and research are necessary, until eventually an "alloy" in medicine is achieved that will resolutely attack resistant strains of acid-fast bacilli and do this without harming normal tissue. But the clinician can now at least approach the patient with laryngeal tuberculosis with optimism and sincerely assure him that arrest of his disease is quite possible.

The 5 per cent sulfamylon® hydrochloride–streptomycin was supplied by Winthrop-Stearns, Inc., New York.

"E.N.T. ESSENTIALLY NEGATIVE"

Avoidance of Pitfalls in Otolaryngology

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"E.N.T. ESSENTIALLY Negative," or the commonest variation on the same theme, "E.N.T. Not Remarkable," is perhaps the grossest misunderstatement recorded on the average patients' chart. Actually, these expressions are written confessions of inadequate examination and improper interpretation. Such an inadequacy may characterize the uninformed and the unskilled, but when the same inadequacy extends to the specialistic group who have been under the spell of the whisper campaign that "otolaryngology is a dying specialty" then a dangerous state of affairs exists. The same physicians who are annoyed and bored by the constant and repetitious present complaint of postnasal dripping, tinnitus, nasal blockage or headache had better get a rubber stamp, or perhaps this maneuver constitutes too great a physical effort.

We otolaryngologists are in the stage of revivals of remedial agents used by our predecessors who did not have the advantages of proper preparation for the specialty, nor did they have the physiological concepts drilled into them. These considerations notwithstanding, present day rhinologists apply silver nitrate over the nasal septum, offering it as a treatment of vasomotor rhinitis, when other colleagues preach the gospel of preserving ciliary activity; they amaze the world and enrich the coffers of pharmaceutical houses by prescribing miracle antihistaminic drugs for the same vasomotor states; they annually try the various letters in the vitamin alphabet from A to Z and claim success in the treatment of deafness; they enthusiastically proclaim that every cell in the ethmoid labyrinth must be exenterated and soon bury the past, if not the patient, in favor of nothing to the millionth in a "shot" and call it allergy; they aerosolize with panacea-like "mist" until they discover that it is merely a "myth"; they antihistaminize for the cover-all diagnostic camouflage of Ménière's disease and nerve deafness, while their colleagues in the other camp achieve startling front-page results with histamines; they ride the successful caravan of irradiation enthusiasts until the effects of the emanation are seen as imagination, with a possible future bombshell in ill effects; which otolaryngologist has the frown and the vasomotor blush? We always did appreciate that the specialty progressed far beyond the scope of the fundamental facts that we know about the various disease entities, but we hoped that we had advanced beyond the

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cautery, the spray and the swab. It is essential that we put our house in scientific order and rule out the empirical, if not harmful, approaches to solving otolaryngological problems.

The dismembered human anatomy cries out in despair at attempts to divide and further subdivide the practice of otolaryngology into highly specialized areas. While we may voice our appreciation for the scientific level attained by our specialty, with the disappearance of empiricism and technical primitiveness, the advancement is impeded by the lack of application of the fundamentals of anatomy, physiology and pathology and by our complacency in assuming that graduation from a medical school spells finality. The detail pharmaceutical salesman too often constitutes the sole source of graduate education, and an imposing office equipment and apparatus are considered the index of skill.

When a structure shows signs of yielding and even tottering, it is only logical that we should seek to strengthen it, that is, provided the original materials used were the very best. To restore it, one proceeds to its very foundation to add support. For a return to sound otolaryngology we return to the study of the total person, our patient. To do this embodies a careful history, a complete examination and a competent analysis of the social, psychological and economic status of the individual. Only in this manner can the physician be in a position adequately to prevent illness and alleviate pain, and to cure or to rehabilitate his patient. Moreover, rational therapy, whether medical or surgical, is based on the premise of an inventory of the total person. We see him, not in terms of a symptom or a case, but as a person; not as a nasal deformity or a form of deafness, but as a person who has these conditions. Only when it is universally recognized that while a specialty deals with a certain selected field, the organs or parts involved are not anatomically, physiologically or pathologically independent but are integral parts of the human economy, will the very foundation for rational approaches to research and treatment be achieved.

One of the noteworthy facts about a large number of diseases that are accompanied with ear, nose and throat disorders is the similarity of symptoms. The various possibilities of otalgia, headache, cough, epistaxis, hemoptysis, postnasal secretion, tinnitus, vertigo, difficulty in swallowing or breathing, just to mention a few, make for interesting clinical investigation. The otolaryngologist can ill afford to look with the proverbial "blinders" worn by the horse but must panoramically view the scene in terms of all systems and all parts of the body in tracking down the causative factor. Too often have we, as specialists, overemphasized the role of the deviated septum and the presence of lymphoid tissue as the "blight areas" of the human economy, ordering their demolition as though they alone governed the well-being of our patients. This approach has led us to occupy the rather sinister role of "economic royalist" in the eyes of our colleagues in other fields and to be the favorite targets of the caricaturist's barbs and the layman's vitriolic writings in widely circulated magazines. By reputation and by our acts, we are known for riding medical and surgical popularity band wagons. As such, we are known to have performed antrotomies of the mastoid on thousands of infants and children who had diarrhea; we did the same on the maxillary sinuses for an overabundant secretion; we irradiated the nasopharynx for all types of deafness and even extended

the indications in the treatment of "colds" and "bronchitis," and we glorified improved rhinoplastic technics by pseudoscientific identification with basic physiological concepts.

In this era of mechanical aids and uncontrolled utilization of antimicrobial agents in lieu of time-taking study of the patient, we make a plea in favor of a return to rationalization and a more thoughtful and sounder application of the newer modalities. Other therapeutic agents and modalities have made their debut with startling hullabaloo, and the innate urge to administer and to find new applications for their use frequently transcends therapeutic rationale and provokes their employment for purposes which are obscure and even irrelevant. There are, and always will be, those members of a profession who will blindly follow a leader of a therapeutic fad and then read into the previous claims of success further embellishments to outdistance even previous claims. As already indicated, the field of otolaryngology, no less than other fields of medicine, has repeatedly witnessed eras of ultraconservatism or ultraradicalism in the management of various conditions. The very terms themselves are beginning to lose face. Conservative therapy has nothing to offer if it is inadequate, and radical care is not to be considered extreme if it offers adequate management in a logical, efficient and effective manner. Only in this manner will the members of the specialty eventually overcome the unwholesome thought that there may be many forms of treatment but only one diagnosis.

The role of the otolaryngologist as a head and neck surgeon has been further appreciated by members of the profession, which has advanced the position of the specialty in its relation to both specific and general problems. New facts and applications of theories in recent years have shown notable progress in the solution of numerous long-standing problems. This progress, in turn, has stimulated renewed interest in diseases of the ear, nose and throat whose cause remains unknown and the treatment inadequate. Refined surgical technics have contributed greated to more adequate management of several special problems. Following is a brief review of some of the more pertinent facts about the field of otolaryngology.

REVIEW OF FACTUAL DATA

Careful studies of operative risks, improved methods of analgesia and anesthesia, development of newer, more precise surgical technics and instrumentaria, the addition of planography to roentgen technics and the discovery of antimicrobial agents have all contributed to the reduction of operation hazards. The former preoperative and postoperative treatment has given way to a more certain management based on modern advances in physiology and biochemistry. Emphasis has been placed on the treatment of the individual rather than the disease. The effects on the patient (children in particular) of psychogenic factors has impressed on the otolaryngologist the importance of the proper environment and cautious psychological preparation (the attitudes and the actions of the physician toward his patient). All these advances have found expression in improved statistics.

From the foregoing it can be concluded that the trend for physicians to prepare themselves properly in knowledge of the fundamentals of otolaryngology has led to a more careful evaluation of the patient as a person, the basic alterations and functions of his morphological structures, both in health and disease, and the judicious employment of every known and proved mechanical, medical and surgical aid in

the restoration of normal physiology. It is certain that we can continue to look forward to further progress when preparation for a specialty is considered a secondary feature of the prime objective—that of being a physician.

Sinus Disease.—In accord with the recognition of the relation of structure to function, there has been a praiseworthy trend toward conservatism not only in the avoidance of operative intervention whenever at all possible but in the selection and modification of operations of a less radical nature. Radical sinus surgery is being performed less than ever before, owing to the recognition of allergy as the basis for rhinological manifestations in the great percentage of cases. Many of the vasomotor states, or the so-called subclinical allergies, affecting the nose have been found to respond surprisingly well to the antihistaminic drugs. In connection with sinus disorders, it is well that due credit be given for the recognition and appropriate treatment of metabolic and endocrinal disease. The use of antibiotics and/or chemotherapeutic agents has not lessened the need for drainage or the removal of infected bone in osteomyelitis of the skull but has added to the successful defense against overwhelming infections occurring as complications of sinus disease. In this respect, recent bombardment of lay literature with the penicillin "mist" treatment of so-called sinus disease is unfortunate. The mist soon will become a myth, and the bubble will burst on an already disillusioned public. The form of operation is dependent on the following factors: (1) the sinus or sinuses affected; (2) the cause; (3) the duration of the disease; (4) the tendency and course; (5) the age of the patient; (6) the patient's physical condition, and (7) his social-economic status, with reference to conserving valuable time lost from work.

Tonsils and Adenoids.—The tonsil problem becomes interesting in the light of the fact that hospital beds are more difficult to obtain, and the introduction of the "closed tonsil season," as a result of confused thinking about poliomyelitis, has had also an important effect on this problem. Evidence that the tonsils may be a potential site of autoimmunization has led to a more careful inquiry into the "better out than in" attitude. Morever, we recognize no underwriter's agreement that any person will be spared all the ills that beset mankind by having his tonsils and adenoids eradicated. Furthermore, with its potential complications, tonsillectomy is not a "minor" surgical procedure. In spite of the two million tonsil operations performed in the United States each year, I question the validity of the indications. We should be inquiring more carefully into why we endanger so many lives to execute what in so many instances constitutes a "prophylactic ritual"; we are the Don Quixotes of medicine who fancy the imaginary enemy and go to the attack.

Increasing emphasis has been laid on the nasopharynx, for we find its examination a matter of mysterious avoidance by so many physicians. True, it does take time and patience to expose, but then the exposure is so rewarding. Unknown malignant lesions of the neck will be found to have their primary origin in the nasopharynx, as will the occasional cause of paralysis of the cranial nerves, ranging from the third to the twelfth, owing to tumors in this area. The source of bleeding or mucopus is not infrequently associated with this space. The lymphoid tissue (the adenoid) in this area has come in for more than its share of attention in recent years, with reference to deafness and its possible amelioration by irradiation.

Considering all of the available evidence, such irradiation (either by roentgen or by radium irradiation) by standardized technics is without danger. It should.

however, be used with restraint and in technically proficient hands, because of the average otolaryngologist's incomplete knowledge of radiobiology and the empiricism of the present dosage. Its use is not a substitute for operation and should be confined to those cases of conduction deafness associated with the proved presence of lymphoid hyperplasia in and about the orifices of the eustachian tube. The importance of history-taking in relation to previous roentgen or radium treatment is stressed, because a repeated series of exposures may produce untoward tissue changes. The use of irradiation in irreversible hearing deficits and without nasopharyngeal inspection is to be deplored and discouraged.

Antimicrobial Therapy.—One of the most progressive developments has been the addition of antibiotics; sulfonamides, streptomycin and/or penicillin, when employed parenterally, have spectacularly added to our defense against overwhelming infections and their complications. It must, however, be recorded that the use of these drugs does not mitigate the necessity for adequate drainage of an infected focus (as in the ear, sinus, pharynx or neck) or for the removal of diseased or osteomyelitic bone. The fallacy of minute dosage has been self evident. Therapeutic levels are frequently dependent on different assays and types of penicillin that are the least toxic, 30,000 units every three hours being basic. Side effects of streptomycin must be carefully controlled by smaller dosage. The influence of streptomycin and dihydrostreptomycin on tuberculosis requires further comment. Its possible effect on scleroma is expectantly awaited. In addition to combating dural involvement, these same chemotherapeutic agents, combined with heparin and bishydroxycoumarin (dicumarol®), (which act to prevent the spread of septic emboli, stabilize the clot and retard the coagulation of the blood) have decidedly influenced the prognosis of the heretofore fatal cavernous sinus thrombosis. The future may hold many possibilities for the effectiveness of the sulfone compounds such as glucosulfone (promin®) and thiazolsulfone (promizole®) on leprosy and related lesions. One almost feels like shouting, "This is only the beginning!" of an era that holds so very much promise.

Tuberculosis of the Larynx.—In the assessment of progress in the treatment of specific diseases of the larynx, much credit must be given to chemotherapeutics. Up to the time of introduction of streptomycin, many of the methods used over a century ago in the treatment of laryngeal tuberculosis were still being followed. It was Albers who, in 1829, advocated tracheotomy for rest of the larynx, and Trousseau and Belloc who, in 1837, advised steam inhalations. After that period, were added a few other adjuvants and modifications of technics which sought to be palliative but were seldom curative. General surgical measures were perfected in the last decade whereby the lungs could be put at rest, these measures having a relatively favorable influence on the laryngeal process. However, none of these measures evidence the profound influence on the healing and prognosis of tuberculosis of the larynx as has streptomycin. Complete and lasting healing of ulcerative lesions of the larynx, pharynx or tracheobronchial tree, regardless of the extent, type and response of the pulmonary lesion, can now be expected in about three fourths of the patients. The pain, dysphagia, swelling and ulceration begin to respond within a few days. The auditory and vestibular disturbances have been reduced since 0.5 Gm. dosage and treatment given over a shorter period of time (45 days) have been in vogue.

Malignant Disease.—Malignant disease is still a horrible specter in our civilization. The number of cases of inoperable cancer of the nose, sinuses, pharynx, ears and larynx continues to be too high to be a credit to an enlightened public or to properly trained members of the medical profession. The need for more careful and complete examination, including adequate biopsies, continues to be stressed. It must be recognized that the occurrence of malignant disease is possible at any age. Strides in surgical procedure and combined irradiation of the aforementioned anatomic parts have been great. We suffer most from the lack of early diagnosis of malignant disease.

Perhaps the most striking advance in general as well as special fields of surgery is the utilization of high frequency current for the destruction or excision of benign and malignant neoplasms of the sinuses. In many respects electrosurgery presents superior advantages over classic surgery. Combined radium and roentgen therapy, with resection of the affected sinus or sinuses, has resulted in a greater percentage of cure than heretofore experienced. The development of surgical technics for the radical removal of large neoplasms, which removal, if followed, of necessity, by mutilation and disfigurement of the face, has resulted in a renaissance of reparative surgery and the use of ingenious prosthetic appliances in the rehabilitation of the patient. The program in plastic reconstruction of anatomic parts represents one of the outstanding achievements in modern surgical practice.

For a great many years laryngologists have tried to make the public "hoarseness conscious." The causes which bring about such a symptom are numerous and should be known not only to the laryngologist and to the general physician but to the speech therapist, who must be aware of the importance of voice changes, and to the layman, who must be made to realize that this symptom is a danger signal of the larynx.

Important strides may be recorded for the management of neoplasms of the larynx. In the past the disciplines of direct laryngoscopy were confined to the few who practiced the art as a specialty. Now the majority of otolaryngologists have acquired the knowledge and the skill for doing this work and are seeing to it that their hospitals have been especially equipped. Laryngoscopic procedures form an important part of every postgraduate curriculum in the specialty.

The importance of conclusive biopsy study has been the result of improved laryngoscopic technics. No longer is guesswork a permissible adjunct in diagnosis. The laryngologist must always bear in mind, however, the possibility of the simultaneous existence of a neoplasm and a specific disease. The laryngologist is also aware of the results of an inadequate biopsy, for when not studied in depth, the true nature of a neoplasm may not be correctly determined. When a lesion involves the vocal edge of the true cord, this portion being of a squamous character, the tumor tends to be less invasive and is termed intrinsic. It is here that laryngofissure is the operation of choice. The epithelium in other portions of the larynx, such as the ventricle, false cord and subglottic area, is respiratory in type. Characteristically, the neoplastic formation in this site is invasive and may be eradicated by a complete laryngeal extirpation. It is apparent that the biopsy study may provide information of diagnostic, prognostic and therapeutic importance.

Rehabilitation.—The hard of hearing, in a small number of well selected cases of otosclerosis, may be benefited by the fenestration operation on the bony labyrinth. These cases must be selected with exquisite care by the latest electroacoustic devices

so as to avoid the further frustration that goes with the possible failure of the surgical restoration of hearing. The greatest strides in the larger sense, however, have been made in the field of audiology in which the otologist, the speech correctionist, the acoustician and the psychologist have combined forces in the retraining and the reeducational process. To the military services we owe a debt of gratitude for an unexcelled opportunity to explore this field for the benefit of a very large handicapped civilian population, recognizing as we do the medical, social and economic implications of deafness.

It is of interest to note that in the past, while the otolaryngologist exhibited some concern in the over-all problems related to hearing, speech and language disturbance, the professional training of the physician has tended toward neglect of these disabilities. This situation has resulted in the dominance of nonmedical workers in the care of such handicapped persons. Only in a few isolated instances have physicians concerned themselves with this subject, apparently so unrewarding professionally. A significant advance has been the realization that a coordinated therapeutic relationship between physicians and nonmedical colleagues in ancillary fields makes it possible to achieve superior results. The contribution of the well trained otolaryngologist to the treatment of persons with speech and hearing handicaps has had a tremendous influence on the recent progress in the field. It involves, however, a willingness on the part of the otolaryngologist to prepare himself for a thorough understanding of the somatic and psychological bases of these disorders. His knowledge of the conventional bases of physical disturbances, in addition to that gained by special interest and study of the physiology of speech and hearing, place the modern, trained specialist in an excellent position to evaluate and to treat these diseases with intelligence and understanding.

1853 West Polk Street.

ROENTGENOLOGIC DEMONSTRATION OF THE FACIAL NERVE CANAL

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IT is a frequent experience that the otolaryngologist's and radiologist's interest in and evaluation of a specific roentogenogram of the mastoid bone varies because of the clinical aspects and implications which may be based on roentgenographic findings. For this reason it has become the practice at the Illinois Eye and Ear Infirmary for the otologist to make his own evaluation of roentgenograms before referring to the radiologist's report. This method of evaluation has given rise to more interest in finer details and has encouraged the correlation of clinical and roentgenographic findings rather than the procedure of relying on the use of roentgenographic findings merely as an aid in determining surgical indications or to determine the type and extent of pneumatization and destruction.

Of the many roentgenographic views which have been suggested and used by various radiologists and otologists, it has become the standard procedure at the Illinois Eye and Ear Infirmary to use the Schuller-Law position and a modified Chamberlain-Towne position in ordinary circumstances; the Stenver and Mayer positions are used when additional information is sought relative to the internal auditory meatus or to the middle ear and lateral attic wall respectively.

In all views, the exact positioning of patient, tube and film is of utmost importance. The Illinois Eye and Ear Infirmary has, fortunately, a technical staff, under the direction of Dr. Roger Harvey, who appreciate this and who possess an intimate knowledge of cranial anatomy and its individual variation with age and skull type. A summary of the technical factors involved in producing accurate and detailed films as presented follows.

In examination of the films taken in the Schuller-Law position, an inconstant finding of a linear radiolucency was noted which conformed to the anatomic location and position of the facial nerve canal. The consistency with which it could be determined was without regard for the general cell type (pneumatic, diploic or sclerotic) of the mastoid bone. Also, this linear radiolucency varied in relative size but never in its location. Review of the literature and of such detailed evaluations of findings on roentgenograms of the mastoid, as described in Mayer's monograph, failed to reveal the identity of this specific entity. This situation is probably based on the fact that the facial nerve canal is not a constant finding in routine films.

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It was felt that verification could be obtained by roentgenographic examination of human skulls and temporal bone specimens placed in the Schuller-Law position. By then placing a fine, radiopaque probe into the facial canal by introduction

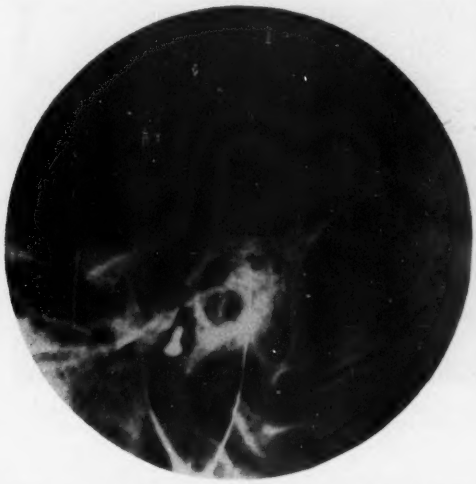

Fig. 1.—Skull in Schuller-Law position. Metal probe inserted into facial canal through the stylomastoid foramen, confirming location of the canal.

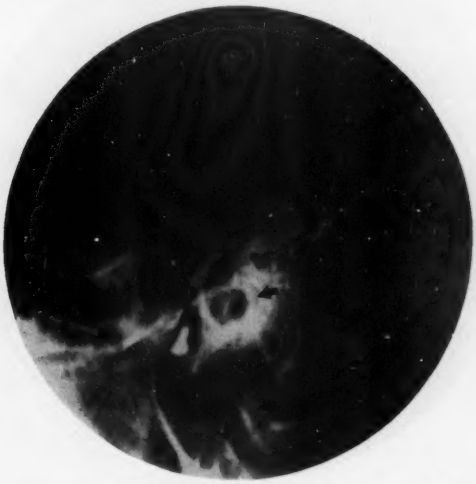

Fig. 2.—Skull and position as in figure 1, with probe removed, showing linear radiolucency in position previously indicated by the probe and illustrating the method used to confirm the identity of this finding as the facial nerve canal.

through the stylomastoid foramen, the finding could be varified. Roentgenograms of this group are shown in figures 1 and 2.

It was also noted that the consistency with which the canal could be demonstrated was a factor of the penetration and exposure used in the roentgenographic technic. The knowledge thus gained indicated that visualization was better with an increase

Fig. 3—Skull in Stenver's position with metal probe in horizontal and descending portion of facial canal. Area facialis of the internal auditory meatus is visualized, but the course through the labyrinthine block is obscured by the extreme bone density.

Fig. 4.—Stenver's view in the living, showing area facialis of internal auditory meatus, course of nerve obscured by density of labyrinthine block and horizontal and descending portions of the facial canal.

of the penetration factor rather than with any change in exposure time. When exposure time was altered instead, surrounding, necessary details were lost by the resultant increase contrast.

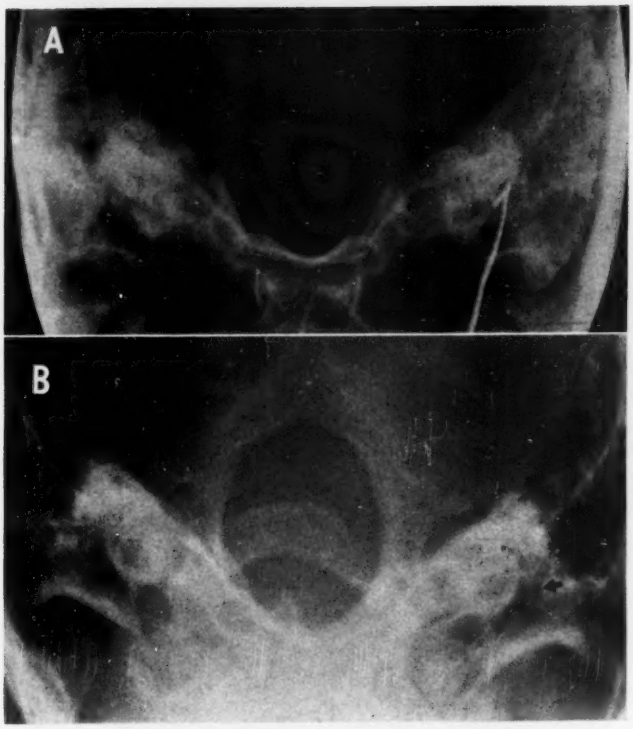

Fig. 5.—*A*, skull in modified Chamberlain-Towne position with metal probe in facial canal. Outer and medial portions of mastoid tip with Bridget's ridge between are shown; lying anteriorly is stylomastoid foramen, and above is the descending portion of facial canal. *B*, Chamberlain-Towne position in the living, showing position of the facial canal as confirmed by probe in *A*.

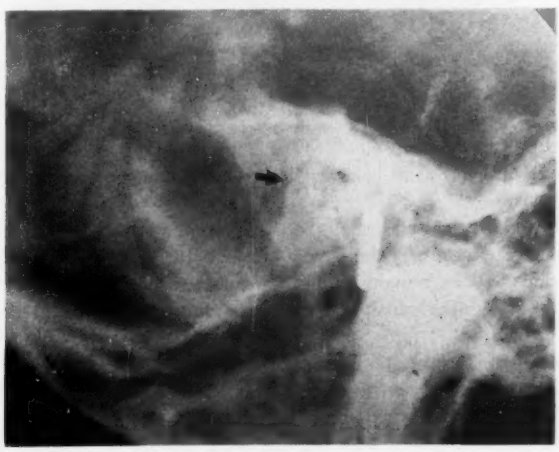

Fig. 6.—Schuller-Law position in the living. Arrow designates an osseous narrowing of the descending portion of the facial canal. History of repeated otitis in childhood; clinical evidence of weakness of lower branch of facial nerve.

Information thus gained on bone specimens was used with patients, and the frequency with which the facial canal could be identified was immediately increased without the loss of other information sought. The dense, sclerotic mastoid offers some difficulty, but when this condition of the bone is known to exist, either clinically or by a preliminary roentgen exposure, the facial canal can usually be shown by further increasing the penetration (kilivolt peak) in making the exposure. Conversely, when some overlying cortical bone has been removed, as in radical or simple mastoidectomy, fenestration, cholesteatoma with erosion or carcinoma, visualization of the facial canal is usually possible with an average penetration, as the cortical bone destruction permits an increase in relative penetration.

Fig. 7.—Extremely narrow facial canal in Schuller-Law position. History of previous idiopathic Bell's palsy.

In both the Stenver and modified Chamberlain-Towne positions, the facial nerve canal was anticipated to be amenable to similar technic on the basis of anatomic projections.

In Stenver's view, the area facialis in the internal auditory meatus is frequently distinct in routine exposures; the course through the dense labyrinthine block is lost in all technics. The remainder of the course, through the middle ear, below the horizontal semicircular canal, and the descending portion can be demonstrated (fig. 3).

The course of the facial canal is more clearly seen in Stenver's view when there is bone loss due to operation or disease in the area of Trautmann's triangle (fig. 4).

Because the mastoid tip is well represented in the Chamberlain-Towne position, it was felt that the stylomastoid foramen and some portion of the facial nerve canal could also be demonsrated by the same technic (fig. 5).

The course of the facial nerve canal is not always uniform, and there is evidence of distortions of minor degree where there has been disease or abnormality during the growth period (fig. 6).

There is also a variation in size of the canal in both normal and abnormal temporal bones. In a small series of patients with a clinical history of a previous Bell's palsy, an extremely narrow canal could be demonstrated (fig. 7). The series is too small at present to suggest conclusions, but the observation would lend support to the vasomotor theory on the cause of idiopathic Bell's palsy if demonstrated with consistency.

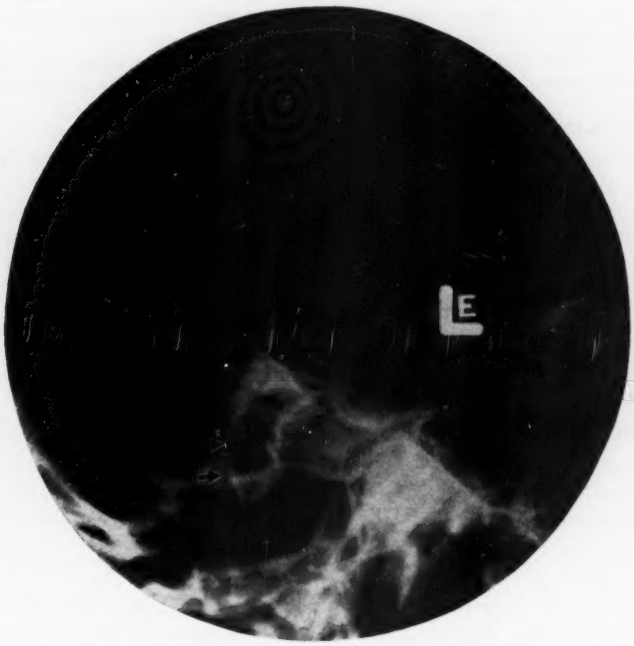

Fig. 8.—Bone erosion by carcinoma shown in Schuller-Law position. Apparent interruption in course of facial canal represents discontinuity in bony canal. Paralysis was present, and nerve was found lying free at time of operation.

Erosion by cholesteatoma or carcinoma in the region of the facial canal has been demonstrated by this technic and confirmed at the time of operation where the nerve has been found exposed or lying free. The preoperative roentgenographic information gave forewarning of the condition (fig. 8).

TECHNICAL DATA

The roentgenographic equipment used is standard and includes a 1.0 mm. target, a rotating anode tube, a Potter-Bucky diaphragm, to absorb as much secondary radiation as possible, and a 5 inch (13 cm.) extension cone; the cone not only aids in localization but also permits immobilization of the patient without the use of head-holding devices, most of which do not take into account the individual variation of the patient. The small focal spot, or target tube, is of utmost importance in order to portray the fine detail of delicate structure.

In the Schuller-Law position the average skull measures 17 cm. from the external ear to the opposite parietal region. For the average skull the routine exposure would be 56 kv., 100 ma., 1 second. In order to visualize the facial canal, an average increase in penetration requires an increase to 62 kv. It is of utmost importance that the position is such that internal and external auditory meatuses are superimposed.

The Chamberlain-Towne position is modified by use of a 45 degree tube tilt instead of the usual 35 degree. On the average adult male skull a 68 kv. peak is used. An increase of the penetration to 74 kv. is required for demonstration of the facial canal. In positioning the patient it is essential that the chin be depressed on the neck and upper thoracic region as far as possible. Failure to achieve this position may project the condyles of the mandible on the mastoid tips, thereby obscuring diagnostic details.

In the average exposure with the Stenver position, a 56 kv. peak is necessary to demonstrate the petrous tip, internal auditory meatus and labyrinthine block. In order to visualize the area facialis and the facial nerve canal, the peak is raised to 62 kv. or 64 kv.

In cases in which it is known that a destructive process exists or an operation had taken place, a smaller increase is made, and, occasionally, under such conditions the average penetration is adequate.

In all of the exposures, the 100 ma., 1 second exposure is constant.

CONCLUSIONS

It is possible to visualize the course of the facial nerve canal in both sclerotic and pneumatic mastoids by using special roentgenographic exposure technics.

By thus visualizing the canal, it is possible to demonstrate abnormalities or distortions in the course of the canal. Such demonstration is best with the Schuller-Law position.

Destruction of the canal owing to granulations, tumor or cholesteatoma can be visualized preoperatively. Such visualization aids in localizing and anticipating abnormally unprotected portions of the facial nerve.

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HISTOLOGY AND HISTOGENESIS OF CHOLESTEATOMA OF THE MIDDLE EAR AND MASTOID

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ALTHOUGH cholesteatomas of the middle ear and mastoid are of relatively common occurrence, and much about them has been observed and written during the past hundred years, their name is a misnomer, their nature is often misunderstood and the theories of their origin are confusing and contradictory. Of the almost universally accepted "invasion theory" of the cause of aural cholesteatomas, Diamant [1] said:

> When a particular view (of a hypothetic nature) regarding cause and effect has once been established in the literature, particularly in textbooks, it is liable, owing to faith in authorities, to get firmly rooted in the consciousness. . . . The adherence to Bezold's hypothesis as the sole alternative must be ascribed to inertia and to innate reluctance to abandon "knowledge" acquired from standard books.

Because of this existing confusion and dogma, and because it is felt that evidence exists which may help to clarify the pathogenesis of cholesteatomas, and stimulated by the as yet unchallenged contention of Tumarkin [2] that cholesteatomas are not epidermic in nature because prickle cells cannot be demonstrated in them, this study was initiated.

DEFINITION

"Cholesteatoma" was defined by Morrison [3] as "a mass of layers of castoff epithelial cells with fatty degeneration and cholesterin crystals on a matrix of subepithelial connective tissue with a squamous epithelial covering."

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Abridgement of a thesis submitted by Dr. Begley to the faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Otolaryngology and Rhinology.

1. Diamant, M.: Cholesteatoma and Chronic Otitis: Etiologic Problems, Arch. Otolaryng. **47**:581-589 (May) 1948.

2. Tumarkin, A.: A Contribution to the Study of Middle-Ear Suppuration with Special Reference to the Pathogeny and Treatment of Cholesteatoma, J. Laryng. & Otol. **53**:685 (Nov.); 737-771 (Dec.) 1938.

3. Morrison, W. W.: Diseases of the Nose, Throat and Ear, Philadelphia, W. B. Saunders Company, 1938, pp. 488; 568-571.

The term cholesteatoma actually is a misnomer. As pointed out by Eggston and Wolff,[4] "oma" signifies a neoplasm or an autonomous new growth of tissue; they suggested that it might be more accurately termed an "epidermoid cyst." Fowler [5] said that it is really an "inclusion cyst."

The prefix is also misleading. Dean and Pfingsten [6] stated that cholesterol crystals and epithelium with fatty degeneration are not alone diagnostic of cholesteatoma. They added that normal cerumen contains more amorphous and crytalline cholesterol than does cholesteatoma. Lederer [7] said that the presence of cholesterol is purely accidental and owes its existence to the decomposition of organic matter in an atmosphere lacking in oxygen.

GENERAL HISTORICAL ASPECTS

An excellent historical review is provided by Lederer,[7] who said that the term cholesteatoma was applied by Johannus Müller in 1838. In the following year, Pappenheim [8] reported the first case of aural cholesteatoma. Virchow [9] in 1855 gave the first explanation of their origin; he concluded that it was the same as cholesteatoma of the brain. Toynbee [10] in 1860 presented the first clear description of these lesions, which he termed "mulluscous tumors," and which, in his opinion, originated in the external auditory meatus. In what was apparently the first systematic postmortem examination of temporal bones, he found, in the dissection of 1,013 diseased ears, 5 containing a mulluscous tumor, one of which projected into the cerebral cavity. Bezold and Siebenmann [11] were the first to consider that the lesion was not a true neoplasm but a product of inflammation.

HISTOLOGICAL ASPECTS

The histology of the mucous membrane of the middle ear and mastoid is of basic interest in the consideration of this problem. A survey of the literature on this point, however, uncovered only a diversity of opinion from which no definite conclusions could be drawn. It is to be remembered, however, that infection may play an important part in the appearance of this membrane; as stated by Eggston and Wolff,[4] "Hyperplasia of ciliated epithelium may occur so that ciliated epithelium may be found in areas within the middle ear cavity where in normal conditions cilia do not occur."

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4. Eggston, A. A., and Wolff, D.: Histopathology of the Ear, Nose and Throat, Baltimore, Williams & Wilkins Company, 1947, pp. 202; 259; 336; 424-434.

5. Fowler, E. P., Jr.: Medicine of the Ear, ed. 2, New York, Thos. Nelson & Sons, 1948, pp. 151, 182.

6. Dean, L. W., and Pfingsten, M. G.: A Chemical and Cytologic Study of Aural and Nasal Exudates as Regards the Chemical Diagnosis of Cholesteatoma, Ann. Otol., Rhin. & Laryng. **43**:484-497 (June) 1933.

7. Lederer, F. L.: Diseases of the Ear, Nose and Throat; Principles and Practice of Otorhinolaryngology, ed. 3, Philadelphia, F. A. Davis Company, 1942, pp. 17; 208-210.

8. Pappenheim, cited by Lederer.[7]

9. Virchow, R.: Ueber Perlgeschwülste, Virchows Arch. f. path. Anat. **8**:371-418 (Oct.) 1855.

10. Toynbee, J.: The Diseases of the Ear: Their Nature, Diagnosis, and Treatment, Philadelphia, Blanchard & Lea, 1860, pp. 147-150.

11. Bezold, F., and Siebenmann, F.: Textbook of Otology for Physicians and Students, translated by J. Holinger, Chicago, E. H. Colegrove Co., 1908, pp. 201-203.

Some authors [12] stated that this mucous membrane is free from glands, while another [13] said that the glands occur sparingly.

In our sections the normal mucous membrane of the middle ear and mastoid proved to consist of simple, nonciliated cuboidal epithelium. This finding is demonstrated in figure 1, a section of a mastoid air cell. Mucus can be seen in the lumen of the space.

PATHOLOGICAL ASPECTS

The histological picture of cholesteatoma was described by Kopetzky [14] as consisting of concentric polygonal lamellas composed mostly of epidermoid cells, between which are found cholesterol crystals. This entire mass is surrounded by a membrane called the "matrix," which is composed of an outer layer of connective tissue rich in blood supply and an inner layer of stratified squamous epithelium. This whole structure forms an invasive cast of the cavity in which it lies. This histological description is essentially consistent with that of other authors.

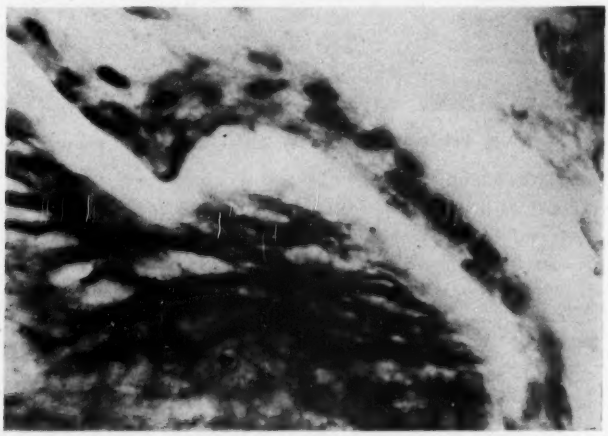

Fig. 1.—Normal mucous membrane of a mastoid air cell. (Hematoxylin and eosin stain; × 1,050.)

Salkowski [15] found that although there is always cholesterol in cholesteatomas, it is not always in a crystalline form but often exists as an ester.

Lautenschläger [16] is said to have demonstrated that the process which destroys bone in the enlargement of a cholesteatoma is the chemical effect of cholesterol and not the mechanical pressure of the tumor. Eggston and Wolff,[4] however, felt that it enlarges its space by pressure erosion.

12. Maximow, A. A., and Bloom, W.: A Textbook of Histology, ed. 4, Philadelphia, W. B. Saunders Company, 1942, p. 640. Sobotta, J.: Atlas of Human Histology and Microscopic Anatomy, ed. 4, New York, G. E. Stechert & Company, 1930, vol. 1, p. 291.

13. Bremer, J. L., and Weatherford, H. L.: A Textbook of Histology Arranged upon an Embryological Basis, ed. 6, Philadelphia, The Blakiston Company, 1944, p. 667.

14. Kopetzky, S. J.: Cholesteatoma, Laryngoscope **43**:118-131 (Feb.) 1933.

15. Salkowski, cited by Rejtö, A.: Cholesteatoma: Some New Principles in Its Treatment, Including the Test for Its Chemical Demonstration, Arch. Otolaryng. **13**:709-713 (May) 1931.

16. Lautenschläger, A., cited by Eggston and Wolff.[4]

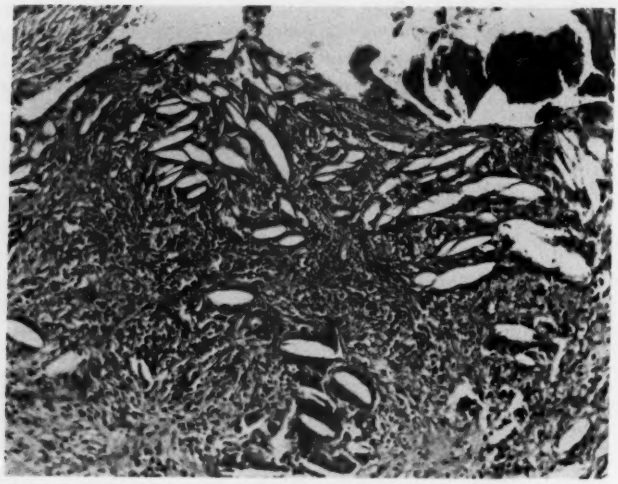

Fig. 2.—Spaces left by dissolved cholesterol crystals. (Hematoxylin and eosin stain; × 135.)

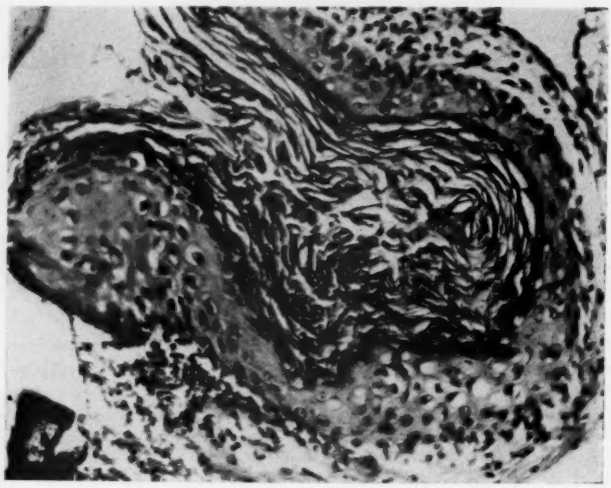

Fig. 3.—Structural characteristics of aural cholesteatoma. (Hematoxylin and eosin stain; × 235.)

McKenzie [17] stated that the seats, or origin, of cholesteatomas in the order of their frequency of occurrence are as follows: attic, aditus, antrum and mastoid process. He had never observed one originating in the eustachian tube.

Morrison [3] said that the presence of this lesion constitutes in every instance a potentially fatal disease. Spiegel and Sommer [18] and Friesner and Braun [19] stated that it is a frequent cause of endocranial complications. Lillie and Stark [20] stressed its insidious, symptomless, destructive effects. The growth may expand into the middle or posterior cranial fossas, the lateral venus sinus, the labyrinth or the facial nerve.

Figures 2 and 3 illustrate sections from an aural cholesteatoma of a white boy 9 years old who had had recurrent attacks of otitis media on the left since infancy, a chronic purulent discharge from the left ear for four months and diminution in hearing on the left for four years. On examination the left tympanic membrane was found to be red and thickened, with a superior perforation, from which a polyp was hanging. A roentgenogram revealed a sclerotic mastoid on the left. Modified radical mastoidectomy was done, and the cholesteatoma was removed. The spaces left by dissolved cholesterol crystals are shown in figure 2, and the layer of vascular and connective tissue and the layer of stratified squamous epithelium of the matrix are shown in figure 3. The stratified squamous epithelium can be seen to be casting off layers of cells toward the center.

HISTOGENESIS

The Primary, or Neoplasm, Theory.—Supporting Opinions: Those who hold that cholesteatomas are primary in origin feel that they arise from congenitally misplaced anlage. Several authors,[21] however, have confused the issue by designating as primary cholesteatomas those which they considered secondary to the catarrhal type of otitis media neonatorum. The term also has been used loosely, even in the recent literature, to designate those lesions occurring without clinical symptoms. Eggston and Wolff [4] stressed that the terms "primary" or "true" should be reserved for cholesteatomas whose origins are embryonic cell rests. They explained that within the brain this tumor arises from the ectoderm of the primitive neural canal and that such a tumor might conceivably occur within the ear as an invasion from the cranium or might possibly arise there from ectoderm of gill cleft origin.

Holmes [21c] reviewed 303 cases of cholesteatomas and stated that certain evidence supported the neoplasm theory. In one case there were bilateral cholesteatomas,

17. McKenzie, D.: The Pathogeny of Aural Cholesteatoma, J. Laryng. & Otol. **46**:163-190 (March) 1931.

18. Spiegel, E. A., and Sommer, I.: Neurology of the Eye, Ear, Nose, and Throat, New York, Grune & Stratton, 1944, p. 205.

19. Friesner, I., and Braun, A.: Cerebellar Abscess: Its Etiology, Pathology, Diagnosis and Treatment, Including Anatomy and Physiology of the Cerebellum, New York, Paul B. Hoeber, Inc. 1916, p. 76.

20. Lillie, H. I., and Stark, W. B.: The Insidious, Symptomless, Destructive Effect of Cholesteatome, S. Clin. North America **6**:1359-1364 (Oct.) 1926

21. (*a*) Almour, R.: The Significance of the Squamous Epithelium in the Cause and Repair of Chronic Middle Ear Disease, Tr. Am. Acad. Ophth. **35**:357-372, 1930. (*b*) Day, K. M.: The Etiologic Factors in the Formation of Cholesteatoma, Ann. Otol., Rhin. & Laryng. **43**:837-850 (Sept.) 1934. (*c*) Holmes, E. M.: A Review of 303 Cases of Cholesteatoma, Ann. Otol., Rhin. & Laryng. **47**:135-143 (March) 1938.

which he compared to the occurence of bilateral congenital cysts anterior to the tragus; in 20 per cent of his cases drainage had lasted less than one year from its onset, and this situation, he stated, would indicate that the cholesteatomas were present before the infection started; in 63 per cent of his cases the patients were 10 years old or younger (this age distribution, he suggested, might indicate that the lesions were present since infancy), and of the involved ears, 36 had anterior or central perforations of the tympanic membrane.

McKenzie [17] favored the primary theory and assumed that suppuration, if it occurred, was a sequela of the cholesteatoma and not vice versa. In his opinion the cholesteatoma might erode the bony meatal wall or the tympanic membrane and thus undergo decomposition after communication with the external air. His reason for this opinion was that discharge from an open cholesteatoma is often nonpurulent, and most often there is no evidence of infection in the areas underlying the cholesteatomatous membrane. He compared these lesions to cerebrospinal cholesteatomas and stressed their structural identity.

Diamant [1] suggested that marginal perforations might be produced from within by the destructive action of a growing cholesteatoma unassociated with infection.

Lindsay [22] reported a case in which he considered that the cholesteatoma was primary because of its size and position despite a history of previous aural complaints and a fetid discharge.

Ersner [23] stated that if a cholesteatoma was found in the temporal bone and there was no evidence of a perforation or scar in the tympanic membrane, or if the lesion was found in the petrous apex with no involvement of the tympanum or mastoid, the growth would be of a primary nature.

Grove [24] supported the primary theory and added one case which he thought upheld it because there was no history or evidence of infection and because the middle ear was entirely shut off from the cavity of the cholesteatoma by a firm bony wall.

Teed [25] stated that true cholesteatomas of the temporal bone do occur but are rare; he said that they have been reported as occurring in almost all parts of the body, including the breast, liver, gallbladder and stomach. He said that they may arise from normally placed ectodermal cells which take on an anomalous function. He reviewed the relationship between the first pharyngeal pouch and the first epibranchial placode in fish, Amphibia, birds and mammals and deduced that these cells may persist in their ectodermal quality and produce skin.

Tumarkin [2] made the statement, "The only otorrhoeas which are not cholesteatoma are primary under the following conditions: A cholesteatoma is primary (1) when, together with a dermoid tumor, no perforation or scar is found on the drum membrane; (2) when the tumor, without a long preceding history of otitis and suppuration, has produced destruction of the labyrinth and nerve deafness; (3)

22. Lindsay, J. R.: Cholesteatoma Associated with an Isolated Perforation in Shrapnell's Membrane, Arch. Otolaryng. **20**:47-56 (July) 1934.

23. Ersner, M. S.: The Diagnosis of Otitic Surgical Lesions, in Kopetzky, S. J.: Surgery of the Ear, ed. 2, New York, Thos. Nelson & Sons, 1947, pp. 55-56.

24. Grove, W. E.: Primary Cholesteatoma of the Temporal Bone, Arch. Otolaryng. **10**:398-408 (Oct.) 1929.

25. Teed, R. W.: Cholesteatoma Verum Tympani: Its Relationship to the First Epibranchial Placode, Arch. Otolaryng. **24**:455-474 (Oct.) 1936.

when there is perforation in the drum membrane but conditions make epithelial immigration impossible; (4) when the delicate enclosing membranes of the tumor itself are completely intact in the middle ear cleft; (5) when the tumor is in a position which, so far as is known, epidermis never invades; (6) when suppuration has been present for a short time and the tumor is so big that it could not possibly have developed in that short time; (7) when the mastoid process is full of a dry pearly tumor which can be easily removed from the bony wall, removal leaving the wall apparently polished with only an occasional indentation and, (8) when the tumor is covered or intermingled with gold or silvery shining cholesterol crystals and when the latter crystals are present to a marked degree in the pus."

Friedman and Quittner [26] reported a case of cholesteatoma of the right mastoid which they considered primary because the patient gave no history of infection and had no involvement of the middle ear.

Wanamaker [27] suggested that cholesteatomas in association with congenital defects of the ear are likely to be primary.

Opposing Opinions: McKenzie admitted in his comparison that although intracranial epidermoid cysts are among the rarest of tumors, aural cholesteatomas are relatively common. In Holmes's [21e] series there were 25 cases in which no cholesteatomas were present at the first operation but were present at the second.

Rodger [28] concluded that cholesteatomas are secondary since they are frequently bilateral, as is otitis media in many cases, and yet bilateral new growths are almost unknown.

Nager [29] collected 100,000 cases with no proved congenital cholesteatomas.

Tumarken [2] made the statement, "The only otorrhoeas which are not cholesteatomas are those antero-inferior infections of the ciliated mucous membrane." He also refuted the primary theory because of the frequent occurrence of cholesteatoma and the rarity of true congenital anomalies. He agreed with the accepted theory that a cerebrospinal epidermoid cyst is epidermic in nature but took the stand that an aural cholesteatoma is not and therefore is not really similar. He attacked Körner's criteria by rejecting points one to seven as indicating only that some pathological process was present before the condition declared itself externally and point eight as being without any significance at all.

Kopetzky [14] considered that on histological grounds no evidence was available to distinguish between intracranial epidermoid cysts and aural cholesteatomas, although they are the end results of distinctly different pathological processes.

Dixon [30] stated that cholesteatomas do not develop in all chronically infected ears but all cholesteatomas which do develop arise from this source.

The Ingrowth or Immigration Theory.—Supporting Opinions: The most widely held opinion on the origin of cholesteatomas is that they result from the

26. Friedman, M. D., and Quittner, S. S.: Cholesteatoma Verum of the Right Mastoid, Arch. Otolaryng. **28**:209-212 (Aug.) 1938.

27. Wanamaker, A. T.: Mastoiditis in Congenitally Deformed Ears, Ann. Otol., Rhin. & Laryng. **48**:140-147 (March) 1939.

28. Rodger, cited by Holmes.[21e]

29. Nager, F. R.: The Cholesteatoma of the Middle Ear: Its Etiology, Pathogenesis, Diagnosis and Therapy, Ann. Otol., Rhin. & Laryng. **34**:1249-1258 (Dec.) 1925.

30. Dixon, O. J.: Otogenous Cholesteatoma, Ann. Otol., Rhin. & Laryng. **56**:986-998 (Dec.) 1947.

ingrowth of stratified squamous epithelium from the external auditory meatus through a marginal perforation in the tympanic membrane into the middle ear.

Bezold and Siebenmann [11] stated that these lesions were a product of inflammation and considered the frequent occurrence of occlusion of the eustachian tubes and perforations in Shrapnell's membrane factors in their cause.

Almour [21a] stressed the importance of adhesive bands in the middle ear, which may follow infantile catarrhal otitis media and block off the tympanum. As a result, an absorption of air and a sucking in and eventual perforation of Shrapnell's membrane with an epithelial ingrowth would follow. He stated that microscopically ingrowing stratified squamous epithelium could be seen to destroy and replace the mucous membrane in its growth into the middle ear. He went on to say that all chronic suppurative lesions of the middle ear in which a marginal perforation of the tympanic membrane exists will show an ingrowth of squamous epithelium.

The importance of the presence of moisture in the development and growth of cholesteatomas was brought out by Day,[21b] who upheld the invasion concept and stated that if a cavity became entirely replaced by epidermis, a dry state and inactivity might result.

Eggston and Wolff [4] presented a case in which they felt they could show microscopically the stratified squamous epithelium of the external canal actually growing through a perforation into the middle ear and there forming a cholesteatoma.

Also in support of the invasion theory is a case presented by Nilsson [31] in which a longitudinal fracture of the pyramid had occurred 10 years previously, with a subsequent formation of an aural cholesteatoma. He considered that the cholesteatoma was formed by invading epidermis secondary to the fracture.

Polvogt [32] presented a case in which microscopic examination disclosed an apparent ingrowth of epidermis within seven days of a perforation after acute otitis media.

Ballenger, Ballenger and Ballenger [33] favored the immigration theory and emphasized the presence of a tonguelike extension of thickened epithelium extending from the superior wall of the external canal to the tympanic membrane in the area of the membrana flaccida.

Kopetzky [34] and Lederer favored the ingrowth theory and felt that mucous membrane is definitely destroyed and replaced by advancing stratified squamous epithelium.

Many other authors [35] also felt that the invasion theory was the most logical.

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31. Nilsson, G.: Attic Cholesteatoma Following Longitudinal Fracture of the Pyramid, Acta oto-laryng. **36**:85-91, 1948.

32. Polvogt, L. M.: The Pathogenesis of Cholesteatoma, Arch. Otolaryng. **9**:597-601 (June) 1929.

33. Ballenger, W. L.; Ballenger, H. C., and Ballenger, J. J.: Diseases of the Nose, Throat and Ear, ed. 9, Philadelphia, Lea & Febiger, 1947, pp. 567; 676-680.

34. Kopetzky, S. J.: Surgery of the Ear, ed. 2, New York, Thos. Nelson & Sons, 1947, pp. 15-16.

35. Bridgett, F. A.: Presentation of Microscopical Sections of Various Pathological Conditions of Ear, Laryngoscope **36**:467-504 (July) 1926. Jackson, C., and Jackson, C. L.: Diseases of the Nose, Throat, and Ear, Including Bronchoscopy and Esophagoscopy, Philadelphia, W. B. Saunders Company, 1946, pp. 203; 290-291. Wolf, G. D.: Ear, Nose and Throat: Symptoms—Diagnosis—Treatment, Philadelphia, J. B. Lippincott Company, 1947, pp. 253; 290-291. Morrison.[3] Spiegel and Sommer.[18]

Opposing Opinions: McKenzie's attitude toward demonstrations of meatal epidermis "pushing its way into the tympanum" was expressed in his statement that "You can see the cholesteatomatous lining passing out to unite with meatal epidermis as it does when spontaneous cure of a cholesteatoma occurs."

Stinson [36] found that particles on the tympanic membrane migrated toward the canal wall, and in no instance did he observe proliferation from the canal toward the drum membrane. This observation seemed to him important evidence that contradicted the invasion theory.

Tumarkin [2] stated that the continuous extension of a sheet of epidermis from the external canal up into the attic and antrum had never been demonstrated by anyone. He refuted the invasion theory with his "quadruple flap operation," which he felt proved that buried epidermis would not form cholesteatoma.

The Metaplasia Theory.—Supporting Opinions: In 1873 Wendt [37] presented the theory of metaplasia, maintaining that under the influence of chronic suppuration the epithelium of the middle ear would undergo a desquamative inflammatory reaction, producing a cholesteatoma.

Metaplasia means that there is a change in the specificity of function and structural characteristics of completely developed tissues. Eggston and Wolff [4] stated that the mucous membrane of the middle ear is subject to cellular multiplication and metaplasia on relatively slight stimuli.

In 1910 Wingrave [38] supported this theory. To the best of our knowledge he is the only author who claimed to have observed prickle cells in a cholesteatoma sac, thereby establishing it as a true stratified squamous epithelium. He stressed the role of desiccation in the stimulation of metaplasia and stated that perforation of the tympanic membrane would lower the temperature and the vapor tension in the middle ear, thus drying the mucosa.

Interesting experimental investigations on various factors producing cellular metaplasia [39] illustrate the wide range of possibilities in the production of this phenomenon.

The widely quoted article of Tumarkin [2] expressed what he termed his modification of the metaplasia theory. He considered that the epitympanum and retrotympanum are normally lined with pavement epithelium which reacts to infection by proliferating and throwing off "paper-like squames," thus forming a cholesteatoma. He stated that the concept of a cholesteatoma being produced from metaplastic ciliated mucous membrane was unnecessary in the explanation of its origin. He denied that the lining of a cholesteatoma is epidermic in nature and stated that no one had ever demonstrated prickle cells in this layer.

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36. Stinson, W. D.: Reparative Processes in the Membrana Tympani: Some Interesting Manifestations, Arch. Otolaryng. **24**:600-605 (Nov.) 1936.

37. Wendt, cited by Eggston and Wolff.[4]

38. Wingrave, V. H. W.: Notes on the Pathogeny of Cholesteatomata, Proc. Roy. Soc. Med. **3**:63-67 (June) 1910.

39. Fütterer, G.: Experimentally Produced Genuine Epithelial Metaplasia in the Stomach, and the Relations of Epithelial Metaplasia to Carcinoma, as Demonstrated by Cases Reported in the Literature, J. A. M. A. **43**:1129-1140 (Oct. 15) 1904. Goldblatt, H., and Benischek, M.: Vitamin A Deficiency and Metaplasia, J. Exper. Med. **46**:699-707 (July) 1927. Hisaw, F. L., and Lendrum, F. C.: Squamous Metaplasia in the Cervical Glands of the Monkey Following Oestrin Administration, Endocrinology **20**:228-229 (March) 1936.

Wolff [40] presented a case that, she said, supported Tumarkin's theory in that patches of stratified squamous epithelium were found in the eustachian tubes.

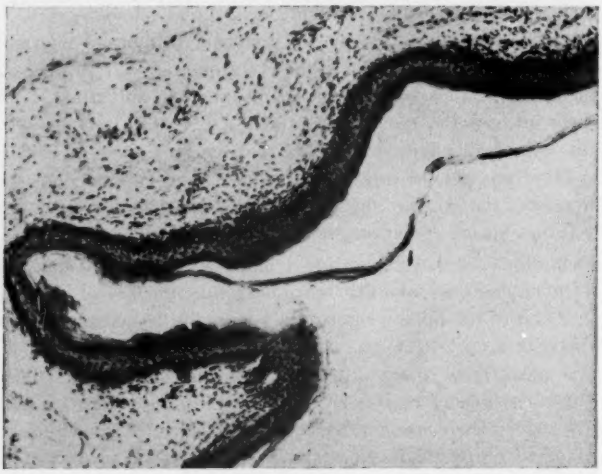

Fig. 4.—Squamous metaplasia and leukoplakia of the urinary bladder. (Hematoxylin and eosin stain; × 150.)

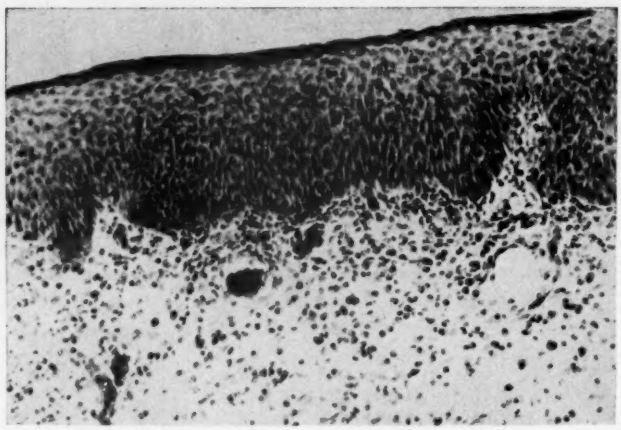

Fig. 5.—Squamous metaplasia of a nasal polyp. (Hematoxylin and eosin stain; × 145.)

Opposing Opinions: McKenzie [17] stated that the supposition that metaplasia is secondary to desiccation was fallible because a cholesteatoma does not develop in an ear in which suppuration has stopped and an open perforation exists.

40. Wolff, D.: The Auditory or Eustachian Tube, Laryngoscope **53**:400-408 (June) 1943.

COMMENT

When the evidence and opinions just cited are balanced, the conclusion may be reached that it is possible for an aural cholesteatoma to originate in the manner indicated by any of these three theories. It would seem, however, that the metaplasia theory of origin is the most plausible in the majority of cases for the following reasons:

Squamous metaplasia with desquamation of surface layers and a picture identical with that of an aural cholesteatoma occurs in many parts of the body in response to irritation, infection and desiccation. Such a picture is seen in figure 4, which shows a section of the urinary bladder of a man aged 71. A similar structure is demonstrated in figure 5, which shows a section from an exposed part of a nasal polyp of a man 41 years old. It would be difficult to assume that stratified squamous

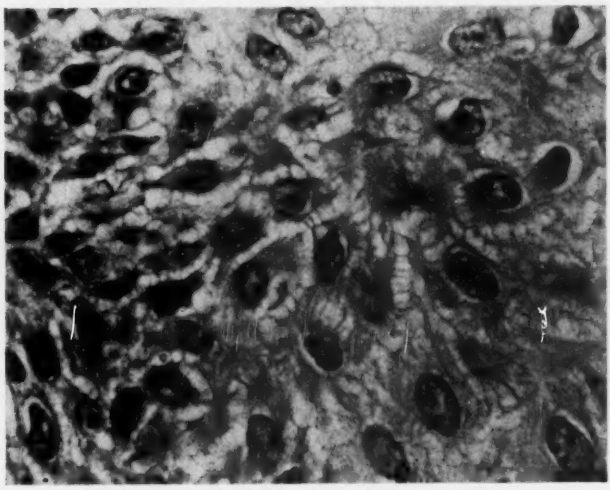

Fig. 6.—Prickle cells in the epithelial layer of an aural cholesteatoma. (Hematoxylin and eosin stain; × 800.)

epithelium appears only in the middle ear in similar circumstances by a different process.

The metaplasia theory seems to be the only one that fulfils all of the criteria of an aural cholesteatoma and can adequately explain its existence in all circumstances. Fowler [5] said that some type of otitis media occurs at one time or another in nearly every person. Eggston and Wolff [4] stated that the mucous membrane of the middle ear is apparently subject to cellular multiplication and metaplasia on a relatively slight stimulus. Thus, one can easily explain the reports of cholesteatomas in cases in which there was no history or evidence of infection or in which the infection existed apparently for only a short period. The occasional existence of a central or anterior perforation thus would be explained.

The modified theory of Tumarkin [2] confuses the metaplasia theory, since he stated that metaplasia actually does not take place. He denied that true stratified squa-

mous epithelium exists in a cholesteatoma since prickle cells cannot be demonstrated in it. True prickle cells may be clearly seen in the epithelial layer of an aural cholesteatoma shown in figure 6, thereby establishing this layer as truly epidermic in nature.

SUMMARY

The normal mucous membrane of the middle ear and mastoid is a simple, nonciliated cuboidal epithelium.

An aural cholesteatoma is composed of a lining of vascular and connective tissue, which supports a layer of stratified squamous epithelium, which, in turn, desquamates into the center of the mass.

The theories of origin of aural cholesteatomas are the primary or neoplasm theory, the ingrowth or immigration theory and the metaplasia theory.

A comparison is made between squamous metaplasia and desquamation in the middle ear and in other regions of the body.

Prickle cells are demonstrated in the lining of an aural cholesteatoma, thereby establishing this layer as truly epidermic in nature.

NASOPHARYNGEAL MALIGNANT TUMOR

An Overlooked Condition

HAROLD L. HICKEY, M.D.
DENVER

IT IS WITH some temerity that I present a paper on a subject which should be familiar to every well trained and observant otolaryngologist. However, the appearance, in a relatively short period, of three cases of malignant growths of the nasopharynx that had been previously overlooked prompted a review of the knowledge and a revision of ideas in the light of modern concepts of pathology, diagnosis and treatment. Accordingly, a study was undertaken that comprised 5 cases in my personal practice, 10 cases from the private practice of interested colleagues and 9 from institutional practice at the University of Colorado medical center from 1940 to 1949 inclusive. Only those cases of true histological malignancy were studied; juvenile angiofibroma, often clinically malignant, was not included. The results of this survey will be summarized later.

A nasopharyngeal malignant growth, while not the most frequent, is possibly the most serious growth of the head and neck. Located in a region designated by Carmody [1] as "the epipharynx, the almost unknown in otolaryngology," the bizarre pattern of initial symptoms diverts one's attention. Inaccessibility to easy examination and biopsy complicates the problem, and symptoms of the primary growth may be so overshadowed by metastases that patients undoubtedly die of widely disseminated malignant changes with the actual site of the causative lesion in the nasopharynx unsuspected.

Although not unknown to some of the earlier writers, recognition of such growths as an anatomic entity does not often appear in the literature before the present century. Bosworth [2] in 1889 collected reports of five cases of carcinoma and added one of his own, the date of the earliest report being 1837. During the same period he collected reports of 18 cases of sarcoma and added one of his own, the earliest report being made in 1855. His description of microsections leads one to believe that some of the so-called sarcomas might now be classified as transitional cell carcinoma. An interesting discussion, including mention of growth characteristics of sarcoma, carcinoma and endothelioma and description of symptoms,

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From the Division of Otolaryngology, Department of Surgery, University of Colorado School of Medicine.

Read before the Section on Laryngology, Otology and Rhinology at the Ninety-Ninth Annual Session of the American Medical Association, San Francisco, June 28, 1950.

1. Carmody, T. E.: The Epipharynx: The Almost Unknown in Otolaryngology, Tr. Am. Acad. Ophth. **45**:255-264, 1939.

2. Bosworth, F. H.: Diseases of the Nose and Throat, Baltimore, William Wood & Company, 1889, vol. 1, pp. 612 and 596.

differential diagnosis and surgical treatment by Miculicz, of Breslau, is found in the handbook by Heymann [3] published in 1899.

Jackson, in 1901,[4] considered primary carcinoma of the nasopharynx a rare condition, since careful search of the literature for the previous 20 years revealed only 13 cases (including the six by Bosworth noted above), to which he added one of his own. He stated that Mortiz Schmidt did not find one such case in a total of 32,997 patients with conditions referable to the nose and throat. Politzer,[5] in his monumental text, made no appreciable reference to aural symptoms, which may be the first indication of a nasopharyngeal malignant condition.

By contrast, the present day incidence of nasopharyngeal growths is said by Martin [6] to be 0.2 per cent of all malignant growths and more than 3 per cent of malignant lesions of the upper portion of the alimentary and the respiratory tracts. Nielsen,[7] in a survey of 10,721 malignant tumors of all sites, found 77, or 0.75 per cent, situated in the nasopharynx. Hoover [8] estimated that for each case of malignant disease of the nasopharynx 13,000 or more patients are seen, and as many as 675 new cases may occur in the United States each year. This apparent increase is undoubtedly due to improved methods of diagnosis and greater alertness on the part of clinicians.

No specific cause can be named for the condition at this site any more than for malignant conditions in general; the nasopharynx is certainly not as subject to irritative insults as some other anatomic areas. Cases have been reported to occur in all decades of life, the greatest number occurring in persons between 41 and 60 years of age. The youngest patient mentioned in the literature was a 2 year old child (reported on by Grotts [9]), in whom a transitional cell carcinoma of the nasopharynx did not receive definitive radiation treatment for about eight weeks because the condition simulated retropharyngeal abscess. When biopsy was finally performed for diagnosis, lateral rectus paralysis, ptosis and metastasis to the cervical glands had taken place; death occurred 10 weeks after onset of the condition.

Two patients in my series were 2½ and 3½ years old respectively, and Cruthirds [10] reported a case of angiosarcoma in a 4 year old boy. Males are affected more than females, in a predominance variously reported at 60 to 90 per cent. A racial susceptibility has been noted in Orientals, especially the Chinese, even in

3. Heymann, P.: Handbuch der Laryngologie und Rhinologie, Vienna, Alfred Holder, 1899, vol. 2, pp. 424-428.

4. Jackson, C.: Primary Carcinoma of the Nasopharynx: A Table of Cases, J. A. M. A. **37**:371-377, (Aug. 10) 1901.

5. Politzer, A.: A Text-Book of the Diseases of the Ear for Students and Practitioners, ed. 5, London, Bailliers, Tindall & Cox, 1909.

6. Martin, H.: Cancer of the Head and Neck, New York, American Cancer Society, 1949, pp. 22-33.

7. Nielsen, J.: Roentgen Treatment of Malignant Tumors of the Nasopharynx, Acta radiol. **26**:133-154, 1945.

8. Hoover, W. B.: Malignant Growths of the Nasopharnyx with Particular Emphasis on Their Frequency, Symptomatology and Diagnosis, S. Clin. North America **27**:577-581 (June) 1947.

9. Grotts, B. F.: Transitional Cell Carcinoma of the Nasopharynx in a Child, Laryngoscope **59**:1355-1360 (Dec.) 1949.

10. Cruthirds, A. E.: Angio-Epithelioma of the Postnasal Space, Ann. Otol., Rhin. & Laryng. **57**:230-234 (March) 1948.

those born in this country. Gardham [11] stated that in Hong Kong 25 per cent of all surgical malignant lesions were in the nasopharynx. Wang [12] of Chengtu, collected 36 cases of such growths in a rather short period, one third in patients between the ages of 25 and 35, only three of whom were female patients; 92 per cent were carcinoma of some type, and extension into the skull involved one or more of all cranial nerves except the fourth and the eighth.

The pathology of nasopharyngeal malignant lesions has been subjected to some changes in ideas with the years. Whereas early descriptions assumed the predominance of sarcoma over carcinoma, newly described histopathological lesions have displaced the former ones. Those of us whose medical training began more than 35 years ago will remember large and small round cell and spindle cell sarcoma; now these terms have largely disappeared. Added to the earlier accepted terms squamous cell carcinoma (further classified in Broders' scheme according to cell differentiation) and lymphosarcoma, there now are lymphoepithelioma and transitional cell carcinoma. Some writers are loath to accept the term lymphoepithelioma. Rarer forms include malignant plasmocytoma, myxosarcoma, salivary gland adenocarcinoma, chordoma, craniopharyngioma and rhabdomyoma sarcomatodes.

Waltner [13] reported two cases of nasopharyngeal plasmocytoma to add to the 13 cases already published. Neither the clinical appearance nor the histological character of these tumors was a reliable indication as to malignant behavior. These tumors should be removed by surgical procedure, which should be followed by high voltage roentgen ray therapy. Davis [14] noted one case of myxosarcoma in a group of 24 malignant nasopharyngeal tumors. Diehl [15] reported one case and cited 10 references to show that salivary gland adenocarcinoma is a rare tumor, constituting only 0.2 per cent of all nasopharyngeal malignant growths. Furstenberg,[16] in his classification according to their tissue derivatives, mentioned chordoma and craniopharyngioma as examples of tumors of teratological origin. Cappell [17] described a rare tumor—rhabdomyoma sarcomatodes—in which a neoplasm of striated muscle was infiltrated by spindle cell sarcoma. The tumor is subject to recurrence and therefore must be removed radically; it is not radiosensitive.

Salinger and Pearlman,[18] in a clinicopathological account of 24 cases, rendered yeoman service in clarifying the various terminologies of previous authors. They

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11. Gardham, A. J., in discussion on Davis, E. D. D.: Diagnosis and Treatment of Tumors of the Nasopharynx, Proc. Roy. Soc. Med. **40**:707-712 (Oct.) 1947.

12. Wang, S. H.: Malignant Tumors of the Nasopharynx, Chinese Med. J., Chengtu ed., **62 A**:121-124 (April) 1944.

13. Waltner, J. G.: Plasma Cell Tumors of the Nasopharynx, Ann. Otol., Rhin. & Laryng. **56**:911-916 (Dec.) 1947.

14. Davis, E. D. D.: Diagnosis and Treatment of Tumors of the Nasopharynx, Proc. Roy. Soc. Med. **40**:707-712 (Oct.) 1947.

15. Diehl, K. L.: Salivary Adenocarcinoma of the Nasopharynx, Arch. Otolaryng. **49**: 275-279 (March) 1949.

16. Furstenberg, A. C.: Malignant Neoplasms of the Nasopharynx, Surg., Gynec. & Obst. **66**:400-404 (Feb., no. 2 A) 1938.

17. Cappell, D. F.: Pathology of Nasopharyngeal Tumors, J. Laryng. & Otol. **53**:558-580 (Sept.) 1938.

18. Salinger, S., and Pearlman, S. J.: Malignant Tumors of the Epipharynx, Tr. Am. Acad. Ophth. pp. 281-316, 1935.

concluded that most of the malignant tumors of the epipharynx should be designated as transitional cell carcinoma, a few as lymphoepithelioma and rarely any as sarcoma. Eggston,[19] who has contributed much to the pathology of otolaryngology, divides lymphosarcoma into three types: (1) lymphoblastic sarcoma, formerly called small round cell sarcoma; (2) reticulum cell sarcoma, formerly called large round cell sarcoma and (3) undifferentiated cell type, simulating epithelial cell and/or mesodermal reticulolymphoid cell. The last-named type is subdivided into (*a*) lymphoepithelioma and (*b*) transitional cell type. The classification of various types of carcinoma and tumors of less frequent occurrence does not differ widely from that of other authors.

Ewing,[20] realizing the multiplicity of terminologies in the histopathology of nasopharyngeal malignant conditions, stated that epidermoid carcinoma or transitional cell carcinoma, when located in a region associated with lymphoid tissues, as in the nasopharynx, becomes difficult to distinguish from lymphoepithelioma. Of the latter growth he recognizes two chief types: (1) Regaud, in which there are syncytial masses or sheets of large polyhedral cells, the nuclei large, vesicular and exhibiting fine chromatin granules, and in which the fine intercellular reticulum of lymphosarcoma is missing on silver stain; (2) Schmincke, in which the epithelial cells are less compact, the alveoli indistinct and in which many lymphocytes and some plasmacytes (plasma cells) may infiltrate the tissue. Ewing's conclusion seems to epitomize the present pathological status:

> The separation of true lymphoepithelioma from anaplastic forms of epidermoid carcinoma, transitional cell carcinoma, lymphosarcoma and the like is often difficult and at times must remain a somewhat arbitrary decision.[20]

Metastases occur almost universally to the cervical glands, in some instances before the primary nasopharyngeal lesion can be detected. The palpable glands most commonly noted are immediately posterior to the angle of the mandible along the anterior border of the sternocleidomastoid muscle, and the posterior cervical chain may be involved early also. The pathways of lymphatic drainage from the nasopharynx to the cervical glands are quite definite. Later, metastases occur to the liver, lung and osseous system, especially the vertebrae.

Local extension toward the base of the skull occurs by contiguity rather than via lymph or blood channels. As Williams [21] and also Martin (cited by the Jacksons [22]) have noted, the most frequent location of the primary tumor in the fossa of Rosenmüller lies directly beneath the foramen lacerum; extension into the cranium by soft tissue continuity, a distance of not more than 1 cm., permits extradural involvement of cranial nerves, often without erosion of bone (fig. 1). Horner's syndrome develops when there is local extension along the internal carotid artery and its investing sympathetic plexus in the foramen lacerum. Involvement of any or all of the cranial nerves may occur, most commonly of the sixth nerve (abducens)

19. Eggston, A. A.: Tumors of the Nose and Nasopharynx, New York State J. Med. **43**:2403-2412, 1943.

20. Ewing, J.: Neoplastic Diseases: A Treatise on Tumors, Philadelphia, W. B. Saunders Company, 1940, ed. 4, pp. 920-922.

21. Williams, H. J.: Malignant Tumors of the Nasopharynx, Tr. Am. Laryng. A. **68**: 30-36, 1947.

22. Jackson, C., and Jackson, C. L.: Diseases of the Nose, Throat and Ear, Including Bronchoscopy and Esophagoscopy, Philadelphia, W. B. Saunders Company, 1946, p. 189.

(fig. 2). Flynn [23] reported a case of transitional cell carcinoma involving all 12 cranial nerves, but the evidence pertaining to involvement of the first (olfactory) and the eighth (auditory) was not quite clear.

The symptoms and signs of a nasopharyngeal malignant process are such that one may be led astray, especially in the early phases of the disease, and there is some variation according to the pathological character of the tumor. Sarcoma produces more evidence of nasal obstruction and bleeding, whereas epithelial tumors are more apt to produce symptoms referable to the cervical glands, aural and cranial nerves. Recognition of symptoms and signs will depend on an adequate history and careful examination. Carmody [1] stressed the fact that diagnosis of adenoid hyperplasia and Thornwaldt's bursitis as well as of malignant growths was

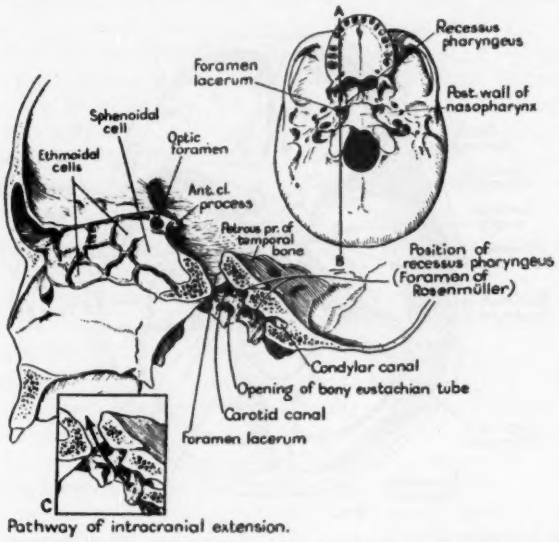

Fig. 1.—Pathway of intracranial extension. From Jackson and Jackson [22]; permission of W. B. Saunders Company.

often missed by failure to examine the nasopharynx; he preferred the mirror and Yankauer speculum to the electric nasopharyngoscope. Theobald [24] has repeatedly pleaded for routine examination of the nasopharynx as a clue to many conditions in the upper respiratory tract, both benign and malignant.

New [25] was one of the first, in 1922, to describe a syndrome of malignant tumors of the nasopharynx, emphasizing the now better known fact that the presenting symptoms are usually referable to regions other than the nasopharynx. In their

23. Flynn, J. E.: Transitional Cell Carcinoma of the Nasopharynx: Report of a Case with Involvement of all 12 Cranial Nerves, J. Iowa M. Soc. **36**:9-11 (Jan.) 1946.

24. Theobald, W. H.: Associated Symptomatology of Diseases of the Epipharynx, Ann. Otol., Rhin. & Laryng. **57**:677-685 (Sept.) 1948.

25. New, G. B.: Syndrome of Malignant Tumors of the Nasopharynx, J. A. M. A. **79**: 10-14 (July 1) 1922.

order of frequency, he listed symptoms referable to the cervical glands, nose and pharynx, ear, eye, intracranial region, gasserian ganglion and the jugular foramen. One patient, as in my series, consulted him for a totally unrelated condition, and the lesion was found on routine examination. In the 79 cases reported, 74 operations had been performed in attempts to relieve the patient from symptoms caused by the nasopharyngeal tumor. Acknowledging that the tumor had been overlooked in many cases because the patients first consulted internists, neurologists, general surgeons or ophthalmologists and a nose and throat examination was not made, he stated that in too many cases the tumor had also been overlooked because a careful nasopharyngeal examination had not been made by the laryngologist.

In a report of 150 cases, Simmons and Ariel [26] found the earliest symptom to be neck swelling; next in frequency were pain in the side of the face and head and

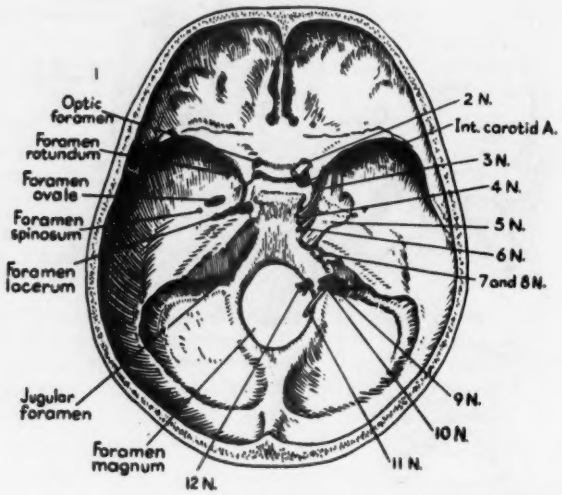

Fig. 2.—Base of skull, showing foramens and cranial nerves. From Jackson and Jackson [22]; permission of W. B. Saunders Company.

other symptoms of cranial nerve involvement. An average of 10.1 months elapsed from the time of the earliest symptoms until a diagnosis was made. Graham and Meyer [27] found that more than half of 26 patients had been under the care of a physician and had been subjected to one or more nasal operations without recognition of the primary lesion. The chief complaint in 62 per cent of the patients was a cervical mass.

Otalgia, stuffiness in the ear, conduction deafness and tinnitus caused by pressure on the pharyngeal orifice of the eustachian tube are common early symptoms. Furstenberg [16] noted changes in the tympanic membrane diagnostic of faulty venti-

26. Simmons, M. W., and Ariel, I. M.: Carcinoma of Nasopharynx: Report of 150 Cases, Surg., Gynec. & Obst. **88**:763-775 (June) 1949.

27. Graham, V. P., and Meyer, R. R.: Experiences with Nasopharyngeal Carcinoma, Radiology **50**:83-91 (Jan.) 1948.

lation of the middle ear. In his series of 40 cases, the average duration of symptoms before a diagnosis was made was 15 months. There was an irresistible tendency of the growth to extend upward and to invade the base of the skull, with resultant cranial nerve symptoms.

Figi [28] evolved a characteristic symptom complex consisting of deep-seated pain in the frontotemporal region; tinnitus, aural pain and deafness; neurological signs referable to the second, third, fifth, sixth, ninth, tenth and twelfth cranial nerves, the commonest being external rectus palsy, and a metastatic mass in the neck, which often preceded other symptoms by several months.

It is an embarrassing but not unknown experience to have a keen neurologist make a presumptive diagnosis and to request the laryngologist to locate the causative lesion in the nasopharynx. In a study of 454 patients, Godtfredsen [29] found ophthalmoneurological symptoms in 38 per cent of patients. The average first symptoms of all types occurred 11 months prior to diagnosis. A less frequent initial symptom of epistaxis was reported by Prohovnik [30] in a case of transitional cell carcinoma of the nasopharynx in a boy 14 years of age. In reporting 12 cases of atypical carcinoma, Fox [31] listed four most important early symptoms of cervical adenitis, earache or deafness, hemoptysis and nasal obstruction. In my experience the two last-named symptoms are more apt to occur late than early and are more characteristic of sarcoma than of carcinoma.

It therefore appears that the symptoms of nasopharyngeal malignant disease are seldom referable to the local lesion except by inference. Certainly, the possibility of such a lesion must be kept in mind in any case of unilateral otalgia, tinnitus and deafness, in the event of unilateral cervical adenopathy or in patients presenting signs of cranial nerve disturbance, especially ophthalmoplegias.

Diagnosis of nasopharyngeal malignant lesions will probably be made more frequently if the examiner keeps in mind the possibility of such a lesion in the presence of suggestive symptoms and signs, even though remote, as noted above. Visualization of the tumor requires a careful nasopharyngeal examination, often no small task. In adults, local anesthesia must be used if necessary, and in children general anesthesia is frequently essential to accomplish the desired result. I derive more information by use of the postnasal mirror, especially the Michel model, but the nasopharyngoscope may be of great service, and the Yankauer speculum offers distinct advantages in some cases.

Biopsy of suspected tissue is imperative for accurate diagnosis and as a means to prognosis and treatment. Specimens for pathological section may be secured with a biting forceps via the nose, with a mirror in the pharynx as a guide, or tissue may be removed under direct vision via the Yankauer instrument; in one case a biopsy was secured with a Kelly adenotome. When tumors have reached appreciable size, biopsy offers no problem, but an early small lesion may require repeated trials.

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28. Figi, F. A.: Malignant Tumors of the Pharynx and Larynx, Wisconsin M. J. **46**: 611-614 (June) 1947.

29. Godtfredsen, E.: Ophthalmologic and Neurologic Symptoms of Malignant Nasopharyngeal Tumors, Acta path. et microbiol. Scandinav. Suppl. 55, 1944.

30. Prohovnik, J.: Carcinoma of the Nasopharynx in a Boy 14 Years of Age, Eye, Ear, Nose & Throat Monthly **24**:187-189 (April) 1945.

31 Fox, C. C.: Carcinoma of the Nasopharynx, Arch. Otolaryng. **48**:390-401 (Oct.) 1948.

As an adjunct to, but by no means as a substitute for, biopsy, Morrison, Hopp and Wu [32] reported an adaptation of the Papanicolaou technic for locating exfoliated malignant cells in smears of vaginal secretions. The procedure is time consuming and painstaking and presupposes familiarity with the normal as well as with the pathological cytology of the nasopharynx. Morrison and his associates observed remarkable agreement between cytological and biopsy findings when the lesion was a surface rather than an interstitial one. It should be borne in mind that malignant cells may also appear in the nasopharyngeal secretions from neoplasms in the nose or accessory sinuses, and the ultimate source must be identified.

Valuable assistance in diagnosis may be found in the use of roentgen rays, both as to the character and extent of the tumor and as to erosion of bony structures at the base of the skull incident to upward extension. Jönsson,[33] by correlating a lateral view of the nasopharynx with an axial submentoparietal projection of the skull, found that malignant tumors presented diffuse asymmetric swelling in the superolateral region in contrast to the more discrete central swelling of adenoids or in tuberculosis. Baylin, Reeves and Kerman [34] described a triad of pathognomonic roentgenologic findings consisting of enlargement of the sphenoidal foramens, erosion of the basiocciput and destruction of the petrous tip. Graham and Meyer [27] found the mesial portion of the greater wing of the sphenoid bone and the petrous apex to be the most commonly involved.

Obviously, early diagnosis improves the immediate prognosis for treatment. In occasional instances a biopsy of a cervical gland with positive indications may be secured without discovery of a primary nasopharyngeal lesion, in spite of diligent search. In one of my cases, the primary lesion appeared in the nasopharynx during the course of roentgen ray therapy of the glands.

Treatment of nasopharyngeal malignant disease has also undergone considerable change over the years. Earliest reports (Bosworth [2]) described radical types of operations, which proved futile and only shortened or made more miserable the existence of the patients. Later, surgical diathermy followed by some roentgenologic treatment was advised. Neck dissections of metastatic glands have been practiced without much success. At present, roentgen ray therapy of the primary lesion and cervical metastases with or without cavitary use of radium or radon seems to represent the consensus of studied opinion. Radiation therapy is usually administered through several external ports by the fractional method of Coutard or by a comparable technic. Since many of the tumors are highly radiosensitive, the immediate response to treatment is very gratifying, even in patients with cranial nerve involvement or palpable cervical glands. Unfortunately, however, recurrences take place and subsequent therapy is less effective.

The five year survival rate is quoted by most authorities as comprising not more than 20 to 25 per cent of cases. In a series of 254 cases, Martin [6] reported a five year rate of cure in only 17 per cent of cases. Lymphosarcoma and lympho-

32. Morrison, L. F.; Hopp, E. S., and Wu, R.: Diagnosis of Malignancy of the Nasopharynx: Cytological Studies by the Smear Technique, Ann. Otol., Rhin. & Laryng. **58**:18-32 (March) 1949.

33. Jönsson, G.: Roentgen Diagnosis of Pathologic Conditions in the Nasopharynx, Acta radiol. **22**:652-664, 1941.

34. Baylin, G. J.; Reeves, R. J., and Kerman, H. D.: A Roentgen and Clinical Study of Nasopharyngeal Malignancies (Lympho-Epithelioma and Transitional Cell Carcinoma), South. M. J. **42**:467-476 (June) 1949.

epithelioma yield a better prognosis than the various types of carcinoma. Lenz [35] reported that 13 patients in a group of 44 patients treated were clinically free from the malignant process after more than five years. He concluded that the results of roentgen ray therapy alone appeared to equal the results with both radium and roentgen rays.

In a group of 271 patients, New and Stevenson [36] reported a 26.8 per cent five year survival rate of the patients with sarcoma compared with an 8.9 per cent survival rate of those with squamous cell carcinoma. The rate of survival of patients treated before the cervical glands became palpable was about double that of those with palpable glands.

Because they illustrate the theme of this paper, reports of three of my cases have been slightly expanded beyond the content in the table.

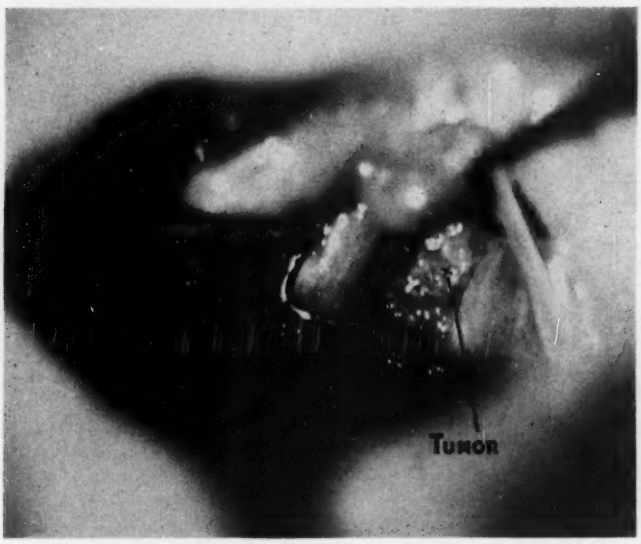

Fig. 3.—Carcinomatous lesion (W.H.H.) found on routine examination.

REPORT OF CASES

W. H. H., a man aged 63, was examined to determine whether hearing loss could be improved. Decreased hearing in the left ear had followed otitis media in early life, and hearing in the right ear had been destroyed 14 years previously by a rifle gunshot through the roof of the mouth with suicidal intent. There was roentgenologic evidence of large fragments of bullet above the right auditory canal and in the petrous temporal bone. He was told that no hearing improvement could be expected. On routine examination, an indurated tumor about 2.5 cm. in diameter was discovered in the nasopharynx on the right, just above the level of the velum palatinum (fig. 3), its presence having been overlooked by four physicians whom the patient consulted previously. Biopsy revealed squamous cell carcinoma. Treatment consisted

35. Lenz, M.: Roentgen Therapy of Primary Cancer of the Nasopharynx, Am. J. Roentgenol. **48**:816-832 (Dec.) 1942.

36. New, G. B., and Stevenson, W.: End Results of Treatment of Malignant Lesions of the Nasopharynx, Arch. Otolaryng. **38**:205-209 (Sept.) 1943.

of the use of radium plaque, insertion of seven radon needles and the use of high voltage radiation. The local lesion resolved, but the patient died six months later from intracranial invasion and aspiration pneumonia.

G. S. D., a married woman aged 53, complained of fulness, slight tinnitus and deafness in the right ear of two months' duration. The right eustachian tube had been inflated twice by an otolaryngologist without relief. There was a fusiform glandular swelling beneath the right ear, and a small ulcerated tumor was located in the right fossa of Rosenmüller. A biopsy of this tumor with general anesthesia indicated lymphoepithelioma (fig. 4). Vigorous roentgen ray therapy has resulted in resolution of the tumor; the cervical gland is no longer palpable, and hearing has returned to normal. The patient is living with no evidence of recurrence 16 months later.

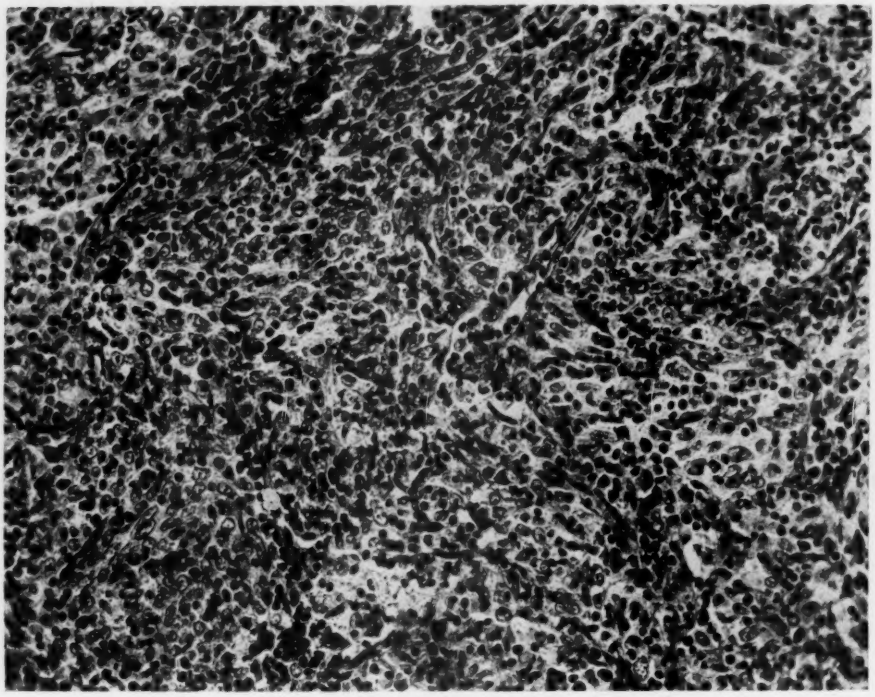

Fig. 4.—Section of biopsy specimen; lymphoepithelioma (G.S.D.).

L. M. R., a widow aged 54, was referred to me by one of my former students, now a general practitioner, who amazed me by a tentative diagnosis of Gradenigo's syndrome. There was a history of earache and deafness on the right, pain over the right side of the face and head of two months' duration and diplopia due to right lateral rectus palsy of 10 days' duration. She had been treated with penicillin for two months without improvement by a physician in a neighboring state. Examination disclosed a tumor, which bled on contact, located in the right fossa of Rosenmüller; evidence of involvement of the fifth and sixth cranial nerves on the right, and conduction deafness due to pressure on the orifice of the eustachian tube. Submental projection of the skull by roentgenographic examination revealed destruction in the region of the petrous apex on the right (fig. 5). Biopsy via a Yankauer speculum indicated squamous cell carcinoma. High voltage ray therapy has resulted in resolution of the nasopharyngeal tumor, a return of function of the fifth and sixth nerves and restoration of hearing. The patient is living and free from clinical signs of recurrence 12 months later.

These cases are cited without censure and merely to illustrate what can occur. I have no doubt that in the past I, too, have missed the diagnosis, but such an occurrence will remain a mystery, for neither patients nor competitors are apt to divulge the information.

This paper is augmented by a survey of 24 cases of nasopharyngeal malignant disease, the details of which will be found in the table appended to the paper. A few significant findings are summarized here. Of the 24 patients, 13 were males and 11 were females. The youngest patient was 2½ years old, the oldest 79, the average age being 48.9 years, with 50 per cent of the patients in the 41 to 60 age group. The most frequent initial symptoms were (1) referable to the ear (otalgia, deafness, tinnitus or fulness), 54 per cent; (2) cervical swelling, 42 per cent, and (3)

Fig. 5.—Basal projection of skull showing erosion of right petrous temporal bone (L.M.R.).

referable to the eye (ptosis or diplopia), 37.5 per cent. The clinical course, signs of extension and metastases offered a variegated picture.

The pathological diagnoses included carcinoma, 13 cases, subdivided into squamous cell, 6, transitional cell, 5, epidermoid basal and squamous cell, 1 and undifferentiated, 1; lymphoepithelioma, 2 cases; sarcoma, 7 cases, subdivided into lymphosarcoma, unclassified, 3, reticulum cell, 3, angioendothelial, 1; one case of malignant chordoma, and one unspecified malignant growth.

Use of high voltage radiation was the therapeutic method in 22 of the 24 cases, and in three radium was used in addition. In two patients neurosurgery was performed for relief from pain; in two, surgical procedures were performed to remove the tumor, during one of which the operation was interrupted by a fatal coronary attack. One patient died before treatment was begun. The final results of treatment

Summary of Data from Survey of Twenty-Four Cases

Patient	Age	Sex	Admission Date	Initial Symptoms	Duration	Additional Findings and Course	Pathological Diagnosis	Treatment	Result
A. A. H.	48	M	4/2/42 (Dr. T. E. C.) 9/24/46 (Dr. H. L. H.)	Fulness, left ear	Several months	Small tumor in nasopharynx on the left removed by Dr. T. E. C. with Kelly adenotome, endothermic cautery	Lymphosarcoma	Roentgen ray (Dr. Coutard)	Living; symptom free 8 yr. later
H. L. M.	28	M	1/26/44	Deafness, left ear; trismus	1 yr.	Left cervical gland removed 18 mo. previously for supposed Hodgkin's disease; minimal granulations, left fossa of Rosenmüller and eustachian orifice; later, large tumor of nasopharynx	Transitional cell carcinoma	Roentgen ray; neurosurgery to relieve pain	Death after 13 mo.
W. H. H.	63	M	1/13/48	No symptoms referable to nose and throat (patient seen because of hearing loss from gunshot wound through mouth in attempted suicide 14 years previously); occasional bloody postnasal discharge	4 mo.	Hard indurated tumor 2.5 cm. in diameter in nasopharynx discovered on routine examination; later, intracranial invasion, coma, terminal aspiration pneumonia	Squamous cell carcinoma	Radium plaque; radon needles; roentgen ray	Local lesion resolved; death after 6 mo.
G. S. D.	53	F	2/21/49	Fulness and decreased hearing, right ear	2 mo.	Small ulcerated tumor in right fossa of Rosenmüller; fusiform swelling right cervical region; conduction deafness, right ear	Lymphoepithelioma	Roentgen ray	Living; symptom free 16 mo. later
L. M. R.	54	F	6/13/49	Fulness, right ear; pain in right side of face and head; diplopia	2 mo. 10 days	Tumor in right fossa of Rosenmüller; involvement of fifth and sixth cranial nerves on the right; erosion of right petrous bone shown by roentgenogram	Squamous cell carcinoma	Roentgen ray	Living; symptom free 12 mo. later
D. M.	62	M	1/25/49	Headache; nasal obstruction; swelling of soft palate; tarry stools	1 mo.	Large tumor filling nasopharynx; generalized metastases	Lymphosarcoma	Surgical removal attempted; coronary occlusion during operation	Death after 5 days
A. K.	77	F	12/28/49	Pain, right ear; anemia; hemoptysis	1 mo.	Large fungating tumor in nasopharynx; fatal hemorrhage	Transitional cell carcinoma	Roentgen ray started	Death after 6 days
M. K.	57	F	9/27/46	Bleeding into throat	9 mo.	Small tumor at junction sphenoid and nasopharynx on the left; cerebrospinal rhinorrhea for one yr.; intracranial extension	Transitional cell carcinoma	Roentgen ray and radium	Death after 18 mo.
D. E.	3½	M	10/28/46	Obstruction to nasal breathing; stridor; bleeding into throat	2 wk.	Large bleeding tumor in nasopharynx; rapid recurrence after repeated removal; terminal meningitis	Angioendothelial sarcoma	Operation and roentgen ray	Death after 21 mo.
E. C.	49	F	5/24/49	Tinnitus, left ear	1 mo.	Tumor 1 cm. in diameter in left fossa of Rosenmüller	Lymphoepithelioma	Roentgen ray	Living; symptom free 13 mo. later
R. F. K.	62	F	6/6/44	Fulness, left ear; tender gland at angle of left side of mandible	6 wk.	Small tumor in nasopharynx 16 mo. after onset; resolution of gland and tumor for 29 months, then recurrence	Malignant growth, type not specified	Roentgen ray	Death after 3 yr.
O. K.	58	M	12/27/48	Enlarging left cervical glands	7 mo.	Hard indurated tumor in nasopharynx on the left; enophthalmos; vertigo, ataxia, diplopia and hemorrhage during treatment	Undifferentiated carcinoma of cervical gland (no biopsy from nasopharynx)	Roentgen ray	Living; symptom free 18 mo. later

Patient	Age	Sex	Admission Date	Initial Symptoms	Duration	Additional Findings and Course	Pathological Diagnosis	Treatment	Result
E. W.	60	F	3/23/49	Swelling, left cervical gland, movable but tender	6 wk.	Small ulcerated tumor in nasopharynx; cystic tumor in left cervical region; fatal hemorrhage from nasopharynx	Leukoplakia of nasopharynx with squamous cell carcinoma in situ; cystic carcinoma of glands with old tubercles	Roentgen ray	Death after 6 mo.
J. L. I.	2½	F	10/4/43	Ptosis, right eye; ophthalmoplegia on the right; swelling, right cervical gland	2 wk.	Involvement of right third, fourth, fifth, sixth, seventh and ninth cranial nerves; paraplegia on the left; nasopharyngeal tumor found on autopsy	Malignant lymphoma, reticulum cell type	None	Death after 4 wk.
C. S.	71	F	12/2/47	Nasal obstruction; bloody nasal discharge; otalgia and deafness on the right	1 mo. 2 yr. 4 yr.	Large tumor of nasopharynx, extending into middle ear; no palpable glands; intracranial extension	Squamous cell carcinoma	Roentgen ray; sodium pteroyl triglutamate (teropterin ®); nitrogen mustard	Death after 14 mo.
E. M. N.	46	F	3/22/39	Dysphagia; weakness, right arm and shoulder; tinnitus, right ear	6 mo.	Tumor in nasopharynx on the right; involvement of second, ninth, tenth, eleventh and twelfth cranial nerves	Malignant chordoma changed from original mixed salivary gland tumor	Roentgen ray	Living 11 yr. later
R. O.	65	M	10/29/42	Swelling in right side of neck; hoarseness; enlarged tonsils; (tonsillectomy two weeks ago)	2 mo.	Ulcerated tumor of nasopharynx on the right; paralysis of the right vocal cord; invasion of nose, orbit; metastases to axillary and inguinal glands	Small cell lymphosarcoma	Roentgen ray	Death after 9 mo.
R. R.	42	M	2/18/43	Pain in left side of face; swelling in left side of neck; deafness, left ear; diplopia	3 mo. 2 wk.	Tumor in nasopharynx on the left; involvement of fifth and sixth cranial nerves; meningitis	Reticulum cell sarcoma	Roentgen ray	Death after 3 yr.
M. S.	46	M	4/14/43	Otalgia, deafness and tinnitus in left ear; diplopia; ptosis, left eye; swelling in left side of neck	5 mo.	First diagnosis Gradenigo's syndrome; involvement of third, fourth, fifth, sixth and seventh cranial nerves; terminal hemorrhage from nasopharynx	Squamous cell carcinoma	Roentgen ray	Death after 22 mo.
C. D. C.	50	M	8/31/43	Diplopia; ptosis, left eye; occipital headache	3 mo.	Tumor in nasopharynx on the left; involvement of second, third, fourth fifth and sixth cranial nerves;destruction of brain tissue, metastases to mediastinum and lungs	Epidermoid carcinoma, squamous and basal cell	Roentgen ray	Death after 8 mo.
F. R.	33	M	1/4/45	Diplopia; vertigo; frontal headache; 30 lb. weight loss	2 mo.	Tumor of midnasopharynx; involvement of third, fourth, sixth (bilateral), ninth, tenth and twelfth cranial nerves	Squamous cell carcinoma	Roentgen ray and radium	Death after 31 mo.
E. O.	79	F	12/3/45	Sore throat; hoarseness; otalgia in right ear; dyspnea	4 mo.	Tumor in nasopharynx on the right, extending downward into thyroid; later, tracheoesophageal fistula, aspiration pneumonia	Reticulum cell sarcoma	Roentgen ray	Death after 16 mo.
H. J. B.	18	M	5/../42 (Chicago) 3/30/48 (U. of Colo. Medical Center)	Deafness, right ear; swelling at angle of mandible; trismus	9 mo.	Tumor in nasopharynx on the right; metastases to ileum and femur; post-treatment fixation of the temporomandibular joint on the right	Transitional cell carcinoma	Roentgen ray to tumor and metastases	Living 8 yr. later
L. W. (Chinese)	47	M	1/4/49	Swelling in neck, more on left side	3 mo.	Biopsy of cervical gland by general surgeon; no ear, nose and throat examination; tumor of nasopharynx; metastases to liver and vertebrae found at autopsy	Anaplastic carcinoma of the cervical gland; transitional cell carcinoma of the nasopharynx	Roentgen ray; neurosurgery to relieve pain	Death after 3 mo.

were as follows: Seven patients are living, symptom free for six months to eleven years after admission (29 per cent), but only three are surviving more than five years. The number of deaths was 17, or 71 per cent. The most frequent known causes of death in this series were sudden hemorrhage from the nasopharynx, intracranial invasion, including meningitis, and aspiration pneumonia. In some cases the immediate cause of death was not learned.

SUMMARY AND CONCLUSIONS

Nasopharyngeal malignant process, a disease entity formerly considered rare, is now reliably estimated to comprise about 3 per cent of all malignant growths of the head and neck. In spite of increased knowledge available, the condition is all too frequently overlooked; this situation is due to the bizarre pattern of symptoms and signs which diverts attention from the primary lesion, to difficulties in biopsy and, unfortunately, to hurried and incomplete examinations.

A brief résumé of pertinent literature is presented to show the trend of changing concepts of the disease, and a group of 24 cases is reported from private and institutional practice. While utilizing refinements in diagnosis and improved methods in treatment, one frequently finds oneself baffled and somewhat helpless in achieving more than palliative control of the primary lesions and their metastases.

934 Republic Building.

Dr. T. E. Beyer, Dr. J. R. Blair, Dr. R. L. Murphy, Dr. T. J. Gromer, Dr. G. L. Pattee, Dr. R. C Shattuck, Dr. R. O. Sherberg and Dr. W. H. Wilson, all of Denver, gave permission to use reports of their cases.

ABSTRACT OF DISCUSSION

Dr. H. James Hara, Los Angeles: Otolaryngologists are chiefly concerned with the problem of an early diagnosis. To this problem there is no short cut. No otolaryngological examination should be considered complete without visualization of every nook and corner of the nasopharynx. In 80 to 85 per cent of adults the nasopharynx can be adequately viewed by a nasopharyngeal mirror. A scrutinizing inspection then is made with a nasopharyngoscope in all cases. Children of school age usually tolerate the nasopharyngoscopic examination. Younger children require general anesthetics for this procedure. Digital examination of the nasopharynx at times is most revealing. I am certain that diagnostic errors are the result of omission rather than commission.

Unilateral, slowly growing (in weeks), asymptomatic nodes in the cervical glands in adults of cancer age should be considered as a metastatic spread until proved otherwise. The most frequent primary site is in the nose and throat. In my experience the cervical nodes are first to be involved. Otological and neurological signs are later symptoms caused by spread of the growth. Cytological study of the nasopharyngeal smears after Papanicolaou's technic and biopsy each has its own place. Negative reports do not preclude the existence of the condition.

Every otolaryngological patient should have the benefit of stereoscopic roentgenograms of the head, neck and chest. If such a plan is universally practiced, overlooked but significant pathological states will be revealed. Benefits derived from such a study outweigh the expenses incurred. The presence of enlarged sphenoidal foramens, the bony erosion of the sinuses and destruction of the petrous tip, as revealed on roentgenograms, are corroborative evidence of the disease, but they are always late signs. Three of Dr. Hickey's series of 24 patients have attained the five year survival cure. The rate of salvage in these patients obviously depends on the type of tumor and on how early and how effectively the radiation therapy is instituted. One of my patients, a physician, has been symptom free since he came under my observation 15 years ago.

As to the high incidence of nasopharyngeal malignant disease among the Chinese in this country, most of these people originated from Canton Province in South China, where there

is also a higher incidence of the tumor as compared with that of northern China. This observation speaks for a hereditary influence in cancer. The Japanese I have treated are also limited to those who originated from the southern part of the island. They are most likely from the same racial background.

DR. R. C. MCNAUGHT, San Francisco: Dr. Hickey's paper covers all the salient points, and I can do little more than emphasize some of them. Those of us practicing in San Francisco have a unique opportunity of observing this tumor, which is not at all rare. San Francisco's Chinatown is said to be the largest community of Chinese outside of China. Dr. Hickey has mentioned the racial tendency toward lymphoepithelioma in the Chinese. In the review of 37 patients with this tumor seen by my associates and me between 1940 and 1950, 16 were Chinese. This ratio of Chinese patients to white patients is about one to one, but when one considers that the total number of patients seen in the clinic is in the proportion of at least 20 white persons to one Chinese and that an even greater disparity exists in the population at large, it is evident that experience suggests that lymphoepithelioma is at least 20 times as common in the Chinese as in white persons.

There is so much awareness of this tumor that it is stressed in the teaching of medical students.

Unfortunately, early diagnosis does not mean cure. All too few patients achieve a five year arrest. Nowhere is there a better example that radio sensitivity is not synonymous with radio curability. These tumors melt away with roentgen therapy, but they do not stay away. Nevertheless, experience indicates that early vigorous treatment of the primary lesion tends to minimize the distressing intracranial complications so prone to appear by direct extension of the tumor through the basal foramens. All patients in whom this lesion is suspected should have roentgenograms made of the skull in the submentovertico projection.

Unfortunately, the primary growth often remains insignificant until long after extensions have become manifest. No one would think of instituting roentgen ray or radium treatment without preliminary biopsy. Sometimes the first sign of the disease is an enlargement of the cervical glands so rapid as to suggest an inflammatory origin. When the cause of cervical adenopathy is obscure, the burden of proof is on the otolaryngologist to rule out the nasopharynx as the site. It is sometimes necessary to take almost random biopsies of innocent-appearing lymphoid tissue. My practice is to use a small ring punch passed through one nostril under observation through a nasopharyngoscope in the other nostril. The tumor often cannot be distinguished grossly from adenoid tissue, and even the microscopic appearance is deceptive. Dense infiltrations of lymphocytes are characteristic of and normal for the nasopharynx. It is not these cells that constitute the tumor. While sarcoma and other bizarre tumors undoubtedly occur in the nasopharynx, my cases have all been anaplastic carcinoma.

DR. HAROLD L. HICKEY: I see why there are no serious differences of opinion in the manner in which this subject has been approached.

The nasopharyngoscope has a great deal of value, and it can be used sometimes in children without a general anesthetic if one becomes adept in its use. I prefer to use the mirror if I can do so.

Dr. Hara mentioned the fact that there may be something in geographic or racial background which makes the Orientals more susceptible to these tumors. Most of the authors who cite this increased susceptibility of the Chinese seem to feel that geography was not the factor. I am glad to hear what Dr. Hara has to say. Dr. McNaught's statistical mention of the frequency of the condition in the Chinese is very interesting.

For many years it has been more or less an obsession of mine to see that our residents particularly and students learn to examine the nasopharynx, and certainly unless one can do so many serious lesions will be overlooked. The method of biopsy in which forceps is used in one side of the nose and a nasopharyngoscope in the other is excellent. One can use the mirror in the throat for biopsy through the nasal fossae.

In the roentgen ray treatment of such lesions, the ability of the radiologist must be taken into consideration. There are altogether too many radiologists, I find, unfortunately, whose treatment is not thorough, and unless the radiologist has a thorough knowledge of the treatment of these malignant growths in an institution in which the opportunity has been large enough to perfect those methods he should not be called on to treat such patients. The results at best are too discouraging.

MANAGEMENT OF ASPIRATED STRAIGHT PINS IN THE BRONCHI UTILIZING THE STEREOSCOPIC FLUOROSCOPE

ALDEN H. MILLER, M.D.
LOS ANGELES

THE COMMON straight pin aspirated into the bronchial tree often presents a most difficult and annoying problem in its removal.

When the pin drops into a bronchus that can be entered by a bronchoscope and the pin actually visualized, its removal is relatively simple through the bronchoscope with a Tucker tack and pin forceps, a side-grasping forceps or even a straight-grasping forceps.

In a few instances when the foreign body is just beyond the field of vision provided by the smallest suitable bronchoscope, gentle, blind probing and grasping have resulted in the pin being satisfactorily engaged and withdrawn into the bronchoscope.

However, the most annoying cases are those in which the straight pin has dropped or worked its way down into a terminal bronchus in the periphery of a lung. The smallest possible bronchoscope affording visualization, as, for instance, the 3 mm. Jesberg modification of the Jackson bronchoscope, many times cannot be passed any nearer than to within 6 or 7 cm. of the upper end of the pin. In such cases fluoroscopic examination has proved that the initial attempts at blind grasping probably took place in bronchi far removed from the foreign body, usually anterior to the object by several centimeters and on either side of its plane. For such cases fluoroscopic direction of the endoscopist's instrumentation is essential. In the hands of some, the use of the biplane fluoroscope and, when necessary, a costophrenic bronchoscope and a pin-bending forceps has resulted in a 100 per cent removal perorally.

At the Los Angeles Childrens Hospital, the use of a newly invented stereofluoroscope has supplanted the use of the biplane fluoroscope and has made much easier the removal of most of the straight pins from the peripheral bronchi. However, one or two problems have arisen that could not be solved by any of the aforementioned procedures. Therefore, typical cases illustrating the problems presented by a straight pin in the bronchi will be cited and commented on.

REPORT OF ILLUSTRATIVE CASES

CASE 1.—*Removal of a straight pin from a bronchus under direct visualization afforded by the bronchoscope.*

J. M., a 14 month old white boy, was admitted to the Childrens Hospital on Aug. 21, 1947 with a history that he had "swallowed" a straight pin three hours before admission and had been coughing since then.

Physical examination showed a well developed, well nourished male child who was not ill. The chest was clear on auscultation and percussion, but a roentgenogram of the chest disclosed a straight pin, point up, in the left midlung (fig. 1).

The next day a bronchoscopy was done with a 4 mm. bronchoscope. The point of the pin was visualized about 5 mm. within the bronchus of the upper lobe of the left lung and was grasped with a small side-grasping forceps and removed.

The postoperative course was uneventful. The patient was asymptomatic the next morning and was discharged.

Comment.—When visualized, the uppermost end of the pin usually can be brought into the bronchoscope easily, disembedding the point from the mucosa when necessary by downward depression, and can be brought on up the bronchoscope. It is not necessary nor advised that the biplane fluoroscope or stereofluoroscope be utilized for these cases.

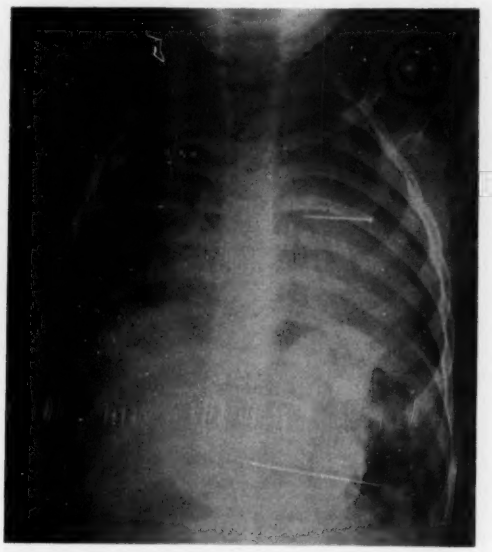

Fig. 1.—Location of aspirated pin in case 1.

CASE 2.—*Removal of a straight pin from a bronchus with the guidance of a fluoroscopist using the stereofluoroscope.*

P. L., a white girl aged 15½ months, was admitted to Childrens Hospital on March 13, 1948 with a history that the child had choked and vomited after her mother's unsuccessful attempt to remove a straight pin that the patient had placed in her own mouth.

Physical examination showed a child who did not appear ill and presented no objective findings. The lungs were clear on auscultation and percussion, but a roentgenogram of the chest disclosed a shadow resembling a straight pin in the left lingular area (fig. 2).

On the second day after admission, the first bronchoscopy was performed with a 4 mm. bronchoscope. The foreign body was neither visualized nor contacted by blind grasping. The same procedure was repeated four days later on March 19, and again the foreign body was neither visualized nor contacted.

Five days later, on March 24, a third bronchoscopy was performed, this time with the stereoscopic fluoroscope. Within two minutes, after one wrong bronchiole was entered, the endoscopic forceps (a small straight grasping) was directed by the fluoroscopist to the head of the pin, which was grasped, and the pin was withdrawn up the bronchoscope.

The total roentgenologic dosage that the patient was exposed to was 31 r. The patient had a cough for a few hours following the removal of the foreign body, but the next morning she was asymptomatic and was discharged that same day.

Comment.—This was the first time that the stereofluoroscope had ever been used in the removal of a foreign body from a bronchus. In the opinion of both myself and Dr. Rolla Karshner, chief of the radiology service at Childrens Hospital, who performed the fluoroscopy, this machine was superior to the biplane fluoroscope that we had used in former years in removing foreign bodies that could not be visualized with the bronchoscope. Excellent three dimensional visualization of this foreign body and the bronchoscopic forceps by the fluoroscopist was obtained. The fluoroscopist knew at once whether or not the forceps was being passed into

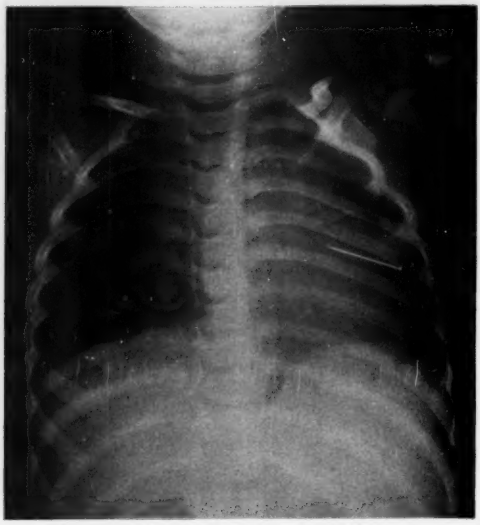

Fig. 2.—Location of aspirated pin in case 2.

the exact plane of the foreign body. Much time was saved by not having to switch the fluoroscopic screen from the vertical to the horizontal position and back again numerous times. Thus, the total length of time the bronchoscope had to be down was lessened as well as the total exposure to irradiation. When at the foreign body, the forceps was much more quickly and correctly applied to it.

THE STEREOFLUOROSCOPE

The stereofluoroscope,[1] as its name implies, is a stereoscopic fluoroscope that produces fluoroscopic images having three dimensions (fig. 3). Foreign bodies, as well as anatomic parts, do not appear as shadows but rather as actual objects that are viewed in their correct relative positions.

1. This new fluoroscope is a product of the Stereo-Fluoroscope Corporation, of Los Angeles, and was developed by LeRoy J. Leishman, who spent many years in perfecting the instrument.

When the stereofluoroscope is being used with the endoscope in the removal of a foreign body, the radiologist is able at all times to see the exact position of the endoscope with relation to the foreign body, and he is therefore able to give correct information to the endoscopist. The three dimensional view makes it possible to proceed much faster than when a biplane fluoroscope is used because the radiologist sees everything from a single viewing position. There is only one screen, and the radiologist therefore does not constantly have to compare the views in two different screens as he directs the endoscopist toward the object to be removed.

This fluoroscope uses two x-ray tubes, which operate on opposite halves of the cycle of the alternating current. These tubes are spaced so that their positions

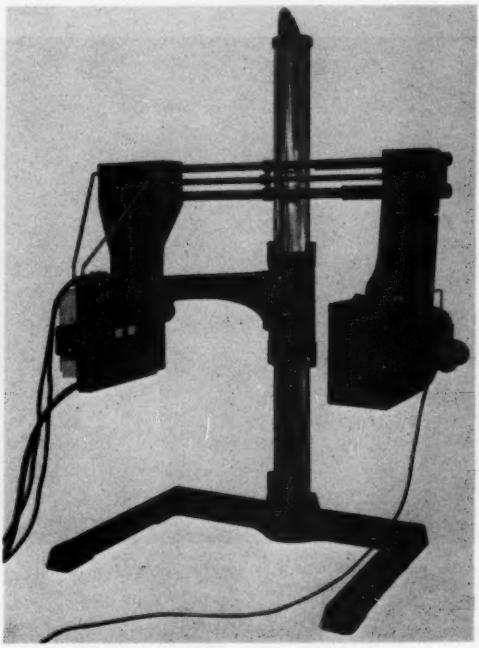

Fig. 3.—Fluoroscope in position for use in the vertical position of the patient.

correspond respectively with the two different positions successively occupied by a single x-ray tube in making a stereoscopic pair of radiographs. In other words, the two tubes are separated by a distance approximately equal to the "stereoscopic shift." The fluoroscopic images cast by the two tubes thus have the same relationship to each other as do the two radiographs in a stereoscopic pair. Although both images appear on the same screen, they are produced alternately instead of simultaneously, and there are 60 pictures per second for each eye.

In the usual use of the machine, the right eye must see the images cast by the left tube and the left eye must see the images formed by the right tube. In order to bring this about, a special optical device and eye piece is provided. When the radiologist's head is positioned at this eye piece, each eye sees through a different

aperture, these apertures being about 1½ inches square (9.7 sq. cm.), and they open and close alternately and in synchronism with the operation of the x-ray tubes. The observer, however, is not conscious of this opening and closing, and each eye appears to be seeing continuously.

It is not necessary for the operator to make adjustments on the machine in order to obtain stereoscopic images. The instrument is arranged so that the necessary adjustments are made automatically. For instance, if the screen is moved away from the x-ray tubes, the tubes automatically move further apart so that their separation will correspond with the stereoscopic shift used in making radiographs. Other necessary adjustments are likewise made automatically without any attention whatever from the operator.

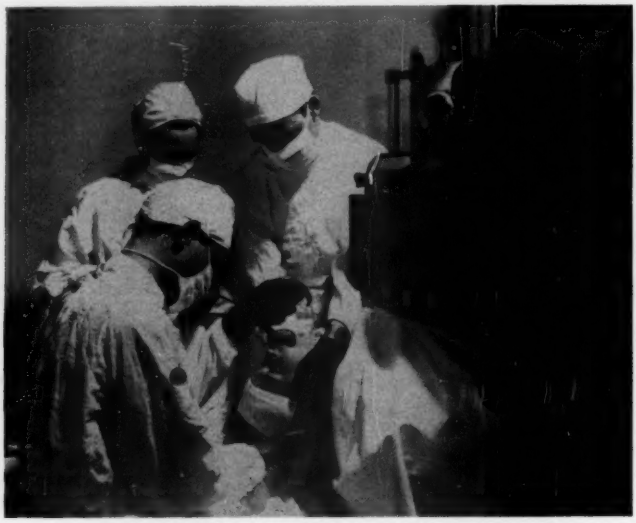

Fig. 4.—Fluoroscope posed with patient in position for a bronchoscopy and instrumentation. (The actual bronchoscopy is not being done.)

Separate diaphragms are provided for the two x-ray tubes to control the spread of the beams, but the two sets of diaphragms are operated by a single set of controls. The beams can never get beyond the confines of the screen.

In order that the patient's skin may receive a minimum of radiation, the distance from the screen to the tube targets is much greater than the screen to target distance on the conventional fluoroscope. This distance on the stereofluoroscope is variable from 30 to 32 inches (76 to 107 cm.).

The control stand is equipped with a cumulative timer, which enables the radiologist to know how many roentgens have been received by the skin of the patient. In the case of the endoscopy reported above, the child's skin received only 31 r.

The stereofluoroscope may be used for either vertical or horizontal fluoroscopy. In one of the accompanying illustrations it is shown in position for horizontal fluoroscopy (fig. 4).

A few interesting observations have already been made in the early use of this fluoroscope at the hospital: (1) The fluoroscopist must have stereoscopic vision himself; (2) until the forceps enters the bronchus that contains the foreign body, the object seems to move about widely with respirations in a fan-shaped area, (3) but as soon as the forceps enters the correct bronchus the foreign body becomes stationary.

This machine has subsequently been used successfully in the removal of a tiny rivet from a peripheral bronchus of the lower lobe of the right lung. However, the attempted removal of another straight pin was unsuccessful, and this case will now be considered.

CASE 3.—*Unsuccessful attempts at removal of a straight pin from a bronchus with use of the stereofluoroscope.*

C. J. A., a 5½ year old white girl, was admitted to the Los Angeles Childrens Hospital on Jan. 21, 1949 with a history that she had swallowed a straight pin a few hours previously. There was the further history that she had been taken to the office of a local otolaryngologist, where roentgenographic examination revealed the pin to be in the hypopharynx. His attempts

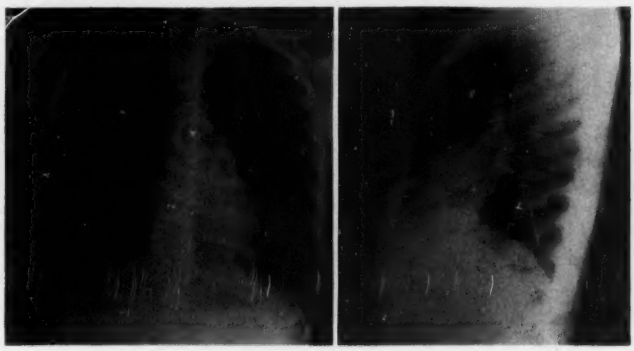

Fig. 5.—Front and side views of location of the pin in case 3.

at removal with general anesthesia were unsuccessful, and a second roentgenogram disclosed the pin now in the lower area of the right lung.

Physical examination showed a normally developed child who was not ill. The lungs were clear on percussion and auscultation, but roentgen examination of the chest indicated a straight pin, point up, low down in a posterior bronchus of the lower lobe.

Three days later bronchoscopy was done with both a 5 mm. and a 4 mm. bronchoscope. The foreign body could not be visualized or contacted by blind probing or grasping in any bronchiole that could be entered by the smallest straight-grasping forceps. A repeat roentgenogram the next day revealed the pin to be a bit lower and farther posteriorly.

Eight days later, on February 2, a second bronchoscopy was performed with a 4 mm. bronchoscope under the stereofluoroscope. The pin could not be contacted, and despite the directions of the fluoroscopist, the smallest straight-grasping forceps could not be passed any closer than to within 1 cm. of the upper end of the pin without entering a bronchus that was easily seen to be anterior to, and either medial or lateral to, the bronchiole containing the pin. After exposure of the patient to 250 r, this attempt was abandoned.

After this first attempt with the stereofluoroscope, the patient's postoperative course was uneventful, and the patient was discharged the following day, to be readmitted five days later.

During this time, a new, very tiny, straight-grasping forceps, the diameter of whose jaws was no greater than the diameter of the head of a straight pin, was made.

On February 9 a second bronchoscopy was done with stereofluoroscopic direction and with the 4 mm. bronchoscope. The new, tiny forceps could be directed downward in the plane of the foreign body, but it would approach only to a distance of about 2 mm. from the uppermost end of the pin. Here, the forceps seemed to encounter soft tissue in an attempt to grasp at the pin. Attempts to withdraw slightly and to enter a different bronchus always resulted in the forceps passing on downward in front of, and either to the right or left of, the foreign body. An Alnico magnet was also used, being passed downward to within 2 cm. of the point of the pin, but the position of the pin was not changed by its pull.

On February 28 a third bronchoscopy with stereofluoroscopic direction was attempted. Roentgenographic examination had revealed the pin to be in approximately the same position. Again, 25 minutes of bronchoscopy with intermittent visualization and direction, with use of a total of 200 r, was unsuccessful. The tiniest forceps could be directed to within about 2 mm. of the point of the pin but could not be passed farther. Repeated attempts to engage the foreign body by a pin-bending forceps introduced through a costophrenic bronchoscope were all unsuccessful. The smallest pin-bending forceps could be passed down only to within 2 cm. of the point of the pin. It seemed as if the jaws of the forceps were too large to enter the bronchiole that contained the pin or else that the foreign body was all embedded in parenchymatous tissue. At least all attempts to enter other bronchi or to approach the pin sideways resulted in the forceps being passed in front of or to one side of the pin but always parallel to it and one or more centimeters from it so that the pin could never be encompassed anywhere along its entire length. The patient was discharged the following day.

About one month later, on March 31, a fourth bronchoscopy with stereoscopic direction was attempted, with the same results. A total of 200 r was used.

On May 31, two months after the last bronchoscopy, the patient was readmitted. She appeared quite healthy. The lungs were clear on percussion and auscultation, and a roentgenogram of the chest revealed that the pin had not moved farther.

On June 15, Dr. Joseph L. Robinson, of the thoracic surgery service, performed a thoracotomy on the right. The right side of the chest was opened with the usual parascapular incision along the course of the sixth rib. The sixth rib was resected subperiosteally. The pleural space contained no fluid, nor were there any adhesions. All the lobes of the right lung appeared normal except for a small area on the mesial diaphragmatic surface of the lower lobe, where there was some contraction of the tissue and an "out-denting." Immediately under this area, the head of the pin could be palpated, seemingly only about 2 mm. from the diaphragmatic surface. There did not appear to be any infiltration surrounding it. A tiny incision was made through the lung tissue directly over the head of the pin. The head was then grasped and easily removed. There was a minimum of bleeding, which was quickly controlled by pressure and absorbable gelatin sponge (gelfoam®). There was no leak of air.

On the first postoperative day the patient's temperature was only 100.4 F. She sat up and appeared well and had only slight pain and cough. On the second postoperative day roentgenographic examination showed that the right side of the chest was clear. On the third postoperative day the sutures were removed, the lung was clear and the patient was discharged. She has remained completely well.

Comment.—Despite the fact that thoracotomy for removal of a straight pin or other foreign body in the periphery of the lung is abhorred, this case appeared to be one that could not be handled successfully otherwise. Jackson [2] states in his textbook that "in these cases the costo-phrenic bronchoscope will solve the problem. In some cases the standard rotation forceps are used . . . ; in other cases the pin-bending forceps . . ." However, in this instance the pin could not be grasped by the pin-bending forceps, even by forcing it through lung tissue, since the pin was always parallel or nearly parallel to the line of direction of the forceps, and thus the shaft could never be engaged.

2. Jackson C., and Jackson, C. L.: Diseases of the Air and Food Passages of Foreign-Body Origin, Philadelphia, W. B. Saunders Company, 1936, pp. 220-224.

Consultation with the thoracic surgeons after the fourth such unsuccessful attempt resulted in their advice that the pin be removed immediately by thoracotomy, as their experience in other cases of metallic foreign bodies left in the lung had always resulted in chronic lung suppuration such as bronchiectasis or pulmonary abscess formation. Case records from their service at Childrens Hospital indicated that an aspirated straight pin left in the lung from only Dec. 21, 1942 to March 5, 1943 resulted in an abscess formation demonstrated by roentgenographic examination.

In February 1948, thoracotomy for the removal of a straight pin (from a lung) that had been aspirated two and a half years previously indicated evidence of so much bronchiectasis that the lower lobe of the right lung was removed.

In another instance, cough, the raising of a large amount of foul sputum and clubbing of the fingers appeared six months after the aspiration of a small nail, which was allowed to remain in the lower lobe of the right lung.

But in March 1943, thoracotomy performed for the removal of an aspirated pin that had been present for only two and a half months disclosed the same findings

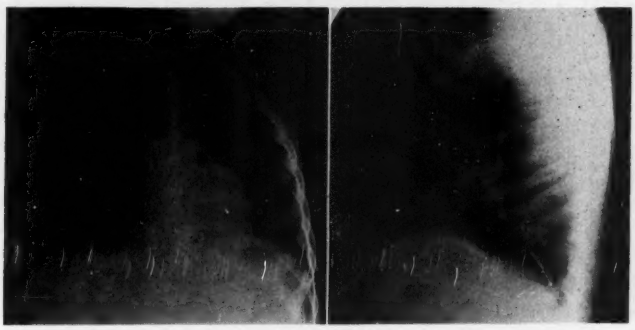

Fig. 6.—Front and side views of location of the pin in case 4.

as in the case previously mentioned, in which attempts at removal under the stereofluoroscope were unsuccessful. That is, the slight amount of reaction present necessitated only simple nicking of the lung tissue over the head of the pin. (This private patient was never seen on the endoscopic service.)

Then, too, the present day chemotherapy and antibiotics make thoracotomy or other transpleural surgery much safer and more easily tolerated, as is evidenced by the short, uneventful convalescence of this patient.

CASE 4.—*Aspirated straight pin in the bronchus complicated by crumbling of the pin.*

Although this patient was not seen in the endoscopic service, the case is cited because it illustrates another problem presented by a straight pin in the lung.

L. M., a 3½ year old Mexican boy, was admitted to the Childrens Hospital because he had had a straight pin in the right lung for two and one half years. The history obtained indicated that at the age of 1 year the patient aspirated a straight pin, which roentgenographic examination revealed to be lodged in the lower lobe of the right lung. Two attempts at its removal by bronchoscopy in a hospital in Texas were unsuccessful. During the following two and a half years, the patient had had frequent recurrent infections of the upper respiratory tract and three attacks of pneumonia.

When he was first seen in the chest clinic of the outpatient department of the Los Angeles Childrens Hospital, roentgenographic examination showed a straight pin apparently in the bronchus of the lower lobe of the right lung, and there was some evidence of bronchiectasis about it. It was considered by members of the chest service to be too far out into the parenchyma to be successfully reached by bronchoscopy, and its removal transpleurally was advised.

On Feb. 4, 1948, a lobectomy was performed on the lower lobe of the right lung by the senior thoracic surgeon, Dr. John C. Jones. There were no adhesions in the pleural cavity, and no reaction was seen on the pleural surface of the lung. The pin could be palpated far down on the posteroinferior aspect of the lower lobe. A small incision was made over the pin, and an attempt was made to grasp the pin with forceps. However, the pin crumbled and broke into many pieces. Since the bronchus leading to the pin appeared very thick and indurated, it was decided to remove the lower lobe of the right lung. The pathological examination was reported as revealing focal atelectasis and bronchiectasis. The postoperative course of this patient was essentially uneventful, and the patient was discharged on the sixteenth postoperative day.

Comment.—This case would seem to indicate that (in this instance) all endoscopic attempts at removal of the pin, which had been in the lung two and a half years, would have been unsuccessful. Surely, it would have crumbled if it had been engaged, especially if by a pin-bending forceps.

SUMMARY AND CONCLUSIONS

Case reports of four patients who aspirated straight pins into peripheral bronchi are cited in order to present the problems in removing this foreign body. From our experience in these cases, my associates and I are convinced that endoscopic removal should be done with the aid of fluoroscopy when the usual bronchoscopy fails to allow visualization or blind grasping of the object. In our hands the stereoscopic fluoroscope is the machine best suited for this fluoroscopic direction of the endoscopist.

If the straight pin cannot be contacted with fluoroscopic direction by any of the smallest forceps, including a pin-bending forceps, its removal transpleurally now seems safe and desirable.

Removal transpleurally should be done relatively early, soon after the endoscopist is convinced that the foreign body cannot be contacted bronchoscopically with the aid of fluoroscopic guidance.

500 South Lucas Avenue.

THERAPY OF THE ALARYNGEAL VOICE FOLLOWING LARYNGECTOMY

A Contribution

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THIS ARTICLE will be devoted chiefly to the description of the intake of air for the production of a pseudovoice by laryngectomized patients. In the case to be described is represented one of the technics, namely, aspiration of air into the esophagus. The publication of such a case seems to be justified because this way of taking in air is not too well known in the literature. A great many papers deal with the speech of laryngectomized patients. Since there are available two American papers that contain most of the literature on the subject, I think it is not necessary to repeat the references here. One of these papers is the classic presentation of Kallen, "Vicarious Vocal Mechanisms," [1] and the other is the survey by Bangs, "Bibliography: Esophageal Speech." [2]

Kallen's proposal to use the term alaryngeal speech for all the different methods taught by the apists and used by patients is logically correct. This term covers the two subgroups, "pseudovoice" and "pseudowhisper."

Pseudowhisper has been dealt with intensively in Kallen's publications and, therefore, will not be included in this article. It may be mentioned here that the pseudowhisper naturally does not carry very far and that voice, therefore, should be the goal of therapy after every laryngectomy. So far I have never failed in achieving this end.

Naturally loud speech is possible only if the patient is able to produce a substituting voice. This production depends on the formation of a pseudoglottis. Kallen enumerates the possible locations of the vicarious glottis from front to back as follows: the dorsum of the tongue and the tensed velum palatini; the base of the tongue and the posterior wall of the pharynx; the two posterior pillars of the fauces; the inferior constrictor of the pharynx; the epiglottis and the two lateral pharyngeal bands, and the external folds of the esophagus with its associate tissues (the cricopharyngeus muscle).[3] It is possible that a patient changes the location of the pseudoglottis. It will soon be seen that the location of the pseudoglottis depends on the location of a vicarious air chamber, but this is not a rule without

1. Kallen, L. A.: Vicarious Vocal Mechanisms: Anatomy, Physiology and Development of Speech in Laryngectomized Persons, Arch. Otolaryng. **20**:460-503 (Oct.) 1934.

2. Bangs, J. L.: Bibliography: Esophageal Speech, J. Speech Disorders **12**:339-341 (Sept.) 1947.

3. van Gilse showed a sound film of a laryngectomized man who had developed spontaneously a pseudoglottis in the area between the left molar teeth and the left cheek. The voice sounded strong and well modulated. (van Gilse, P. H. G.: Parabuccal Voice, read at the Eighth Convention, International Society for Logopedics and Phoniatrics, Amsterdam, 1950.)

exceptions. In other words, although the pseudoglottis may migrate with the change in location of the air chamber, it also happens that one and the same air chamber is used in a single case for stimulating a different pseudoglottis for vibration. It must be admitted that some of the locations are, somehow, hypothetical, since exact pharyngolaryngoscopic observations interfere with the formation of a pseudoglottis at a certain place, for example, between the epiglottis and the two pharyngeal bands. While the vicarious air chambers and the air in them can be seen roentgenologically, the pseudoglottis can really be located exactly only if it is located in the mouth of the esophagus. For even if one looks into the opened mouth and sees the back of the tongue retracted toward the pharyngeal wall there is still the possibility that the real pseudoglottis is located below this narrow space. The same supposition holds for narrowed pillars of the fauces. Even if stroboscopy reveals vibrations of the pillars or of the tensed velum palatini, it still cannot be decided whether those vibrations are not only transferred by air originally brought into vibration at the entrance of the esophagus. This region can be made visible "laryngoscopically" only if the tongue is protracted and the pillars of the fauces are separated from each other. Under these conditions it may happen that a pseudoglottis above the esophagus is forced to disappear. Even if the esophageal mouth is the only existing pseudoglottis, a swallowing movement occurs during the optic observation and interferes with it, especially in patients who take in air by swallowing. Therefore the procedure is difficult for both the patient and the physician. The conclusions derived from this procedure should, accordingly, not be taken so decisively with relation to the location of the pseudoglottis or the existence of one pseudoglottis only.[4]

In some locations of the pseudoglottis vibrations may be stimulated during either the period of taking in or that of expelling air. Since the impulse for vibration depends on a rather strong pressure exerted on every glottis, only swallowing of air or drawing in of air into the esophagus by strong inhaling movements will have a vibrating effect. When the pseudoglottis is above the entrance of the esophagus, many patients take in some air by relaxing the muscles of the pharynx and flattening the tongue. Taken in in this way, the air will not be under sufficient pressure to stimulate vibrations. In other words, if the air chamber is above the esophagus only the expelled air—the expulsion occurring by strong contractions of some pharyngeal muscles—will be able to produce vibrations of the pseudoglottis.

The number of sounds, syllables and words a patient can produce in his alaryngeal speech depends on the amount of air taken in as well as on the economic use of this air. It stands to reason that a bigger air chamber will be more able to sustain a longer utterance after one intake of air than a smaller one, and from this observation it follows that the esophagus is the ideal air chamber for alaryngeal speech.

There are two methods of taking air into the esophagus: swallowing and inhaling. No physician will be surprised by the use of the expression swallowing, not only because food is usually taken in this way but also because air swallowers are well known in medicine. The term "inhaling into the esophagus" may seem strange to readers uninformed about the alaryngeal voice. It has been shown in

4. The same thing may be said for roentgenographic studies. Lindsay, J. R.; Morgan, R. H., and Wepman, J. M.: The Cricopharyngeus Muscle in Esophageal Speech, Laryngoscope **54**:55-65 (Feb.) 1944.

the literature that some laryngectomized patients acquire the faculty of filling the esophagus with air during the act of inhaling into the lungs without swallowing. Burger and Kaiser,[5] Brighton and Boone,[6] Negus,[7] Seemann,[8] Kallen [1] and I [9] have dealt with aspiration of air into the esophagus. My first case has been described by Kallen in his paper, so I shall refrain from repeating the description. Since 1928 I have had many laryngectomized patients for vocal treatment and have always used successfully the air aspiration method, so far without exception. According to the experience of other writers, the ability to inhale into the esophagus depends on unknown anatomic and functional peculiarities and, perhaps, also on postoperative anatomic conditions of the individual patient. I therefore have to consider it as at least possible that I have seen by chance only patients who offered predispositions favorable for them to learn the inhaling method.

The reader will, of course, ask why inhaling into the esophagus should be preferable to swallowing. Several points may, in my opinion, answer this question. Many writers have mentioned the solace for the laryngectomized patient that lies in his ability to speak aloud again. There is no doubt that it helps the patient a good deal if before his operation he hears laryngectomized persons speak aloud. McCall and Stover [10] certainly are right in recommending preoperative training in esophageal voice: "Since the most crucial concern of the patients, next to survival, is ability to talk, postponement of the operation for a week or so for the purpose of assuring them a good esophageal voice afterwards is justified." The alaryngeal voice is somehow close to the physiologic state, and to come close to the physiologic state is what every diseased person wants. The closer to the physiologic state the better! Now, everybody knows that, normally, speech is connected with inhaling. To offer to the patient the possibility of taking in the air which supports voice in an almost normal way is in tune with his desire to approach normalcy and is, therefore, a psychic stimulus.

Furthermore, it has been proved that one, not even very deep, inhalation (into the lungs) suffices to fill the whole esophagus with air. With one act of swallowing, in many cases, only an amount of air sufficient for not more than a few words goes into the esophagus. Several swallowing movements must, therefore, be executed to produce a longer phrase. Of course, there are exceptions, for example, persons who have learned to swallow with one gulp enough air to count up to 20. With inhaling, enough air is taken in immediately to "nourish" a phrase of 10 or more words. (The patients are inclined at the beginning to emit too much air, that is, to waste it. They must learn not to use more air than necessary for speaking with an audible voice.) The readiness for even a longer phrase after one inhalation is another advantage of the inhaling method.

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5. Burger, H., and Kaiser, L.: Speech without a Larynx, Acta oto-laryng. **8**:90-116, 1925.

6 Brighton, G. R., and Boone, W. H.: Roentgenographic Demonstration of Method of Speech in Cases of Complete Laryngectomy, Am. J. Roentgenol. **38**:571-583 (Oct.) 1937.

7. Negus, V. E.: Affections of the Cricopharyngeal Fold, Laryngoscope **48**:847-858 (Dec.) 1938.

8. Seemann, M.: Speech After Laryngectomy, Casop. lék. česk. **63**:984-994 (June 28); 1011-1021 (July 5) 1924.

9. Froeschels, E.: Lehrbuch der Sprachheilkunde (Logopädie) für Aerzte, Pädogogen und Studierende, ed. 3, Leipzig and Vienna, F. Deuticke, 1931, pp. 373-377.

10. McCall, J. W., and Stover, W. G.: Laryngectomy for Laryngeal Cancer: A Review of 45 Cases, Laryngoscope **54**:659-676 (Dec.) 1944.

That learning to inhale into the esophagus can be mastered very quickly, whereas learning to swallow often takes several weeks, speaks in favor of the former method. Another advantage, shown in one of my cases, is the possibility of having the pseudoglottis vibrate during inhaling, thus adding to the possible duration of phonation. Of course, should a therapist encounter a patient who has greater difficulties learning the aspiration than the swallowing technic, it stands to reason that he will prefer the latter mechanism.

Fig. 1.—Esophagus filled with air by inhaling.

The case history of one patient I treated recently may illustrate the advantages mentioned above.

F. S., a man 58 years old, had a laryngectomy on July 11, 1950. Three to four weeks before he came to me he had learned from another laryngectomized patient how to swallow air and how to use belching for a voice substitute. At that time, September 1, he had learned to count to four after one swallowing. I advised him to shift to the inhaling method. Three days later, on the second visit, he had given up air-swallowing and could count to 12 after one inhalation. He could also speak phrases containing up to eight words "in one breath." He admitted feeling

much better than when he swallowed air. I saw him only six times, for he had to sail for his native country on September 14. His voice was well understandable at a distance of at least five yards (4.6 meters), and he could count up to 15 in one breath. My advice that he talk more slowly resulted in greater loudness. The roentgenograms taken by Dr. S. Fineman show what I think is best expressed in Dr. Fineman's report.

Roentgenographic Report (Dr. Fineman).—"Roentgenographic examination of the thorax of F. S., obtained in the right anterior oblique position, during inspiration and expiration, with

Fig. 2.—Esophagus empty of air after counting.

special reference to the air content in the esophagus, indicates the following observations: The film (fig. 1) obtained after inspiration disclosed a considerable column of air in the entire esophagus. A second film (fig. 2) obtained after inspiration, followed by the patient's count of 14, revealed complete emptying of the esophageal air content."

In addition to this report, it can be stated that after the intake of air into the esophagus the diaphragm is lower than after counting. This finding corresponds to the physiological breathing procedure, namely, that the diaphragm flattens during inhaling and rises during exhaling.

Much has been written about the role that the air in the stomach plays in esophageal speech. While Stern [11] advocated the importance of the gastric air bubble, Seemann and others opposed his opinion. In the case described here there is a visible difference between the first and second roentgenogram. But since the pressure of the diaphragm against the stomach is naturally stronger in the state of inhaling (fig. 1) than in the state after exhaling (fig. 2) it is, in my opinion, hard to decide whether the different density of air is not due to the different shape of the stomach.

SUMMARY

The topic of voiced alaryngeal speech is discussed briefly. Special stress is placed on the technics of taking in the necessary air for this kind of voice production. Inhaling into the esophagus is preferable to swallowing. A case history demonstrates the advantage of the inhaling method.

133 East Fifty-Eighth Street.

11. Stern, H., in Denker, A., and Kahler, O.: Handbuch der Hals- Nasen- Ohren- Heilkunde, mit Einschluss der Grenzgebiete, Berlin, Springer-Verlag, 1928, vol. 5, p. 494.

Case Reports

LYMPHANGIOMA OF THE LARYNX

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AND
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Lymphangiomas are rare laryngeal tumors. We have been able to find but 6 cases on record. New and Erich,[1] reviewing 722 cases of benign growths of the

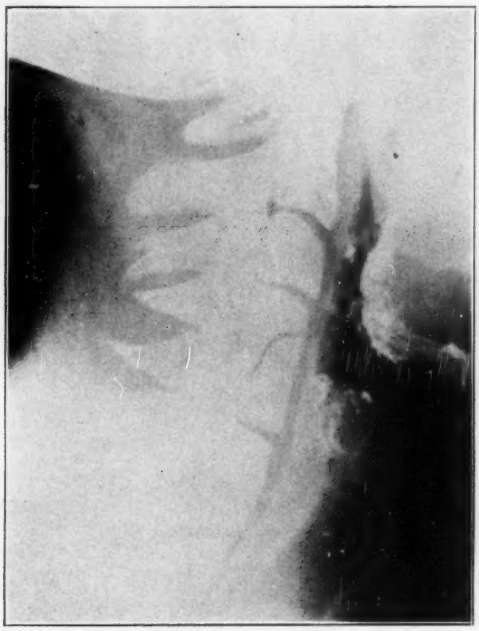

Fig. 1.—Roentgenogram showing outline of tumor.

larynx seen at Mayo Clinic over a thirty year period, report 25 cases of true angioma of the larynx, only 1 of which was a lymphangioma.

Sweester[2] divided angiomas into two types: first, the adult type, usually rounded, projecting, sometimes pedunculated and situated on or above the vocal

1. New, G. B., and Erich, J. B.: Benign Tumors of the Larynx: A Study of 722 Cases, Arch. Otolaryng. **28**:841 (Dec.) 1938.

2. Sweester, T. H.: Hemangioma of the Larynx, Laryngoscope **31**:797-806, 1921.

cords; second, the infantile type, sessile, flattened or diffuse, occurring below the vocal cords and generally producing dyspnea. The majority of lymphangiomas of the larynx reported on have had a smooth or papillary surface. They are relatively larger than hemangiomas, are pale and transparent and, on examination with a

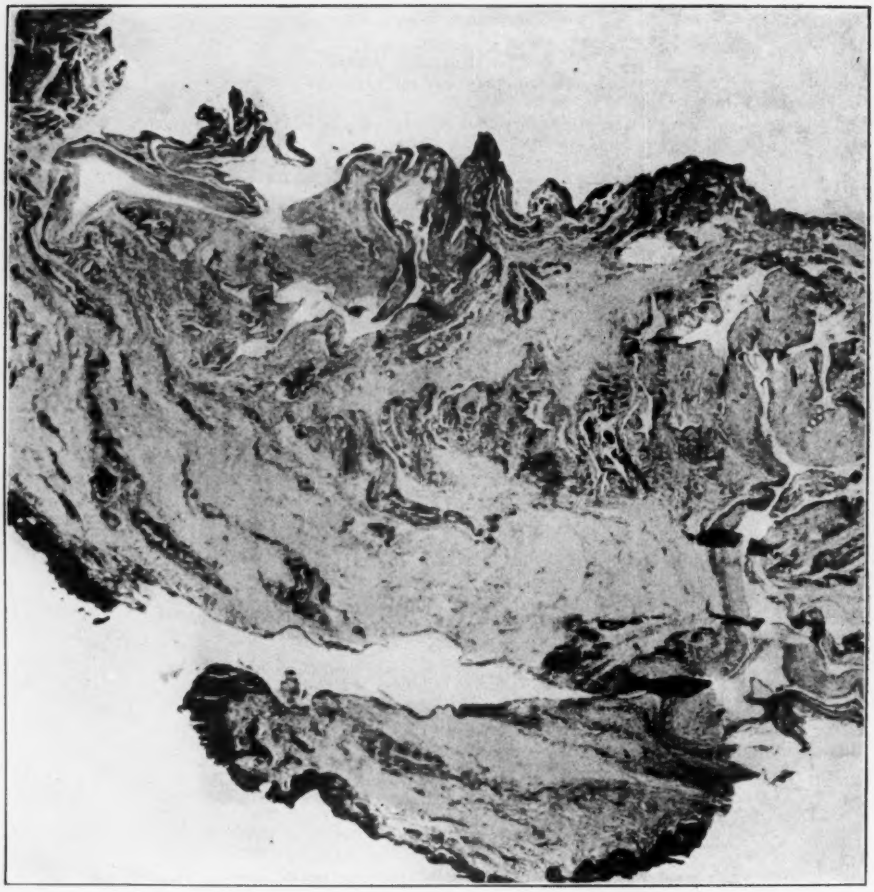

Fig. 2.—Photomicrograph of tumor diagnosed as lymphangioma.

probe, offer more resistance than do hemangiomas. In the larynx, the tumor has been found in various locations, and it has been a solitary one. The case of lymphangioma reported by New and Erich was a small polypoid nodule situated at the junction of the anterior and middle third of the right vocal cord. The inferior surface of the left vocal cord at the anterior commissure was the site of the

growth of a polypoid lymphangioma, described by Robinson.[3] The junction of the posterior end of the left aryepiglottic fold and ventricular band was the point of attachment of a semisessile, rounded tumor observed by Tweedie.[4]

The symptoms produced by lymphangiomas of the larynx are essentially the same as those caused by other types of benign tumors. The common symptom is hoarseness. The presence of dyspnea depends on the type, size and location of the tumor. When the tumor involves the epiglottis or arytenoid cartilages, the patient may experience some degree of dysphagia.

REPORT OF A CASE

The patient, a well developed and well nourished white man aged 28, was admitted to the ear, nose and throat service of the Murphy General Hospital on

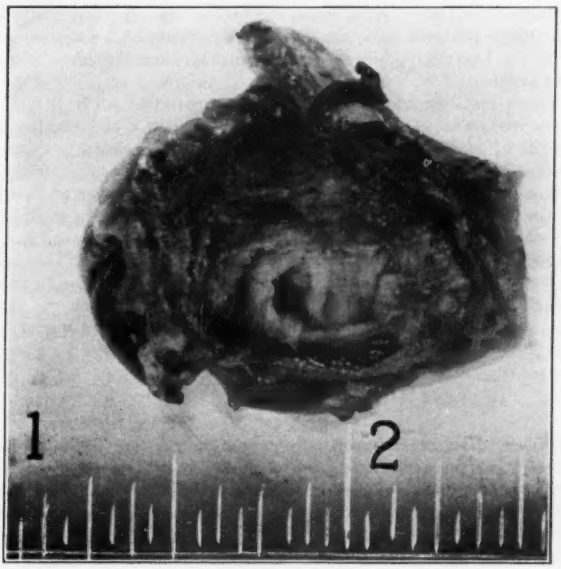

Fig. 3.—Gross specimen.

Jan. 3, 1948, with the chief complaint of gradually increasing difficulty in swallowing. Five months prior to admission, he began to notice some difficulty in swallowing solid foods, and at the time of admission was unable to ingest anything but fluids. There was a subjective sensation of "lump in the throat" but no history of hoarseness or dyspnea. Prior to the onset of dysphagia, the patient had always been in excellent health. The results of the general physical examination and laboratory tests were essentially normal, and nothing abnormal was noted throughout the subsequent course.

3. Robinson, H. B.: Case of Polypoid Growth (Lymphangeioma) of the Larynx, Proc. Roy. Soc. Med. Laryng. Sect. 88, 1907-1908, vol. I.

4. Tweedie, A. R.: Lymphangioma of the Larynx, Proc. Roy. Soc. Med. (Laryng. Sec. 99) 1927-1928, vol. 21.

On inspection of the larynx with a mirror and a laryngoscope, a pale, pinkish gray cystic-appearing mass, measuring about 4 cm., was seen involving the posterior wall of the larynx overlying the esophageal mouth. The epiglottis and other laryngeal structures presented a normal appearance. A biopsy specimen of the cyst was taken. Microscopic examination of the biopsy specimen read as follows: "The epithelium is stratified squamous in type and shows a regular and orderly growth. The underlying connective tissue is loose and edematous and is transversed by numerous thin-walled blood vessels and capillaries. The lesion is histologically nonspecific."

Operation with cocaine anesthesia was performed on January 27, by direct laryngoscopy. The laryngeal knife was inserted into the tumor to determine the extent of its vascularity. On puncture about 1 ounce (28.35 Gm.) of clear, colorless fluid escaped. A tonsil-seizing clamp was used to grasp the free margin of the tumor, and a laryngeal snare encircled the base of the cyst, which was attached to the posterior laryngeal wall. As the snare was tightened, a coagulating current cauterized the base. The tumor was removed with little difficulty. No bleeding was encountered.

The gross specimen was a soft, fleshy mass measuring 1.8 by 1.7 by 1.1 cm. It was covered on three sides by a translucent epithelial coat. The basal portion was roughened and irregular. On section, the surface was pinkish gray and almost gelatinous. Microscopic sections revealed a lining epithelium of fairly normal stratified squamous epithelium. Underlying this epithelium was a zone of loose and somewhat edematous connective tissue, which was traversed by small capillaries and thin-walled lymphatic vessels. In one area was a partially collapsed cystic space lined by endothelium and possessing a thick fibrous wall. This apparently represented a larger lymph channel. The diagnosis was lymphangioma. (The histologic diagnosis was concurred in by the Army Institute of Pathology.)

The patient's postoperative course was uneventful. Repeated mirror examinations and laryngoscopy six weeks after operation showed no evidence of recurrence, and the patient was completely asymptomatic.

COMMENT

Treatment of angiomas is generally surgical removal of the tumor by direct laryngoscopy, but due precautions must be taken to control hemorrhage. In all cases reported, the tumor has been removed perorally.

Clinical Notes; New Instruments and Technics

TREATMENT OF CHRONIC OTITIS MEDIA WITH A MIXTURE OF GLYCERITE OF HYDROGEN PEROXIDE, STREPTOMYCIN AND PENICILLIN

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In the quest for an ideal ear drop for the common chronic otorrhea, the gamut of chemical agents has been tried, from the time-honored boric acid-alcohol solution to the sulfonamides, glycerite of hydrogen peroxide and the antibiotics. Although each one gives a certain degree of clinical satisfaction, there is still room left for improvement. The literature on the subject is so voluminous that one is at a loss concerning the merit of one chemical over that of the other.

The reports on the treatment of chronic purulent otitis media by Brown and Owen [1] with glycerite of hydrogen peroxide; by Loeb [2] and Rawlins [3] with penicillin, and by Harris, Kilham and Finland [4] with streptomycin were indeed very encouraging. Assuming that the separate use of these three agents has brought about a high percentage of cure, why not use them all in a shotgun mixture so that they would be lethal to both gram-negative and gram-positive organisms?

Perhaps some persons would say that this combined use is unscientific on the ground that any of the three is just as effective. On the other hand, the glycerite-streptomycin-penicillin mixture might possess a synergistic action similar to that of penicillin with the sulfonamides in the treatment of systemic gram-positive infections.

In hope that such a synergism is existent and that the three drugs in combination are more potent than the original substances, the next step was to observe any chemical incompatibility. As there were no facilities for the pharmacologic study of the resultant mixture, I decided, roughly, that so long as no bubbles were seen, no oxidation was going on in the mixture.

Probably it will be pardonable to use this mixture on an empiric basis because the medical conditions in Cebu City are far behind those in the United States. Facilities for the bacteriologic studies of aural secretion are nonexistent; hence, I cannot even tell the predominant organisms in the cases of chronic otitis media and, much less, the in vitro sensitivity of the causative bacteria with regard to the mixture. For another reason, the economic condition of the patients does not warrant roentgenologic examination of the temporal bone, so I have to depend only on the clinical signs of a complicating cholesteatoma. Therefore, this study is a hit and miss proposition.

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1. Brown, E. A., and Owen, W. E.: Treatment of Chronic Purulent Otitis Media with Glycerite of Hydrogen Peroxide, Arch. Otolaryng. **43**:605 (June) 1946.

2. Loeb, W. J.: Penicillin Ear Drops in Treatment of Suppurative Otitis Media, Arch. Otolaryng. **43**:586 (June) 1946.

3. Rawlins, A. G.: Local Use of Penicillin in Alcohol and Glycerine for Chronically Running Ears, ibid. **46**:71 (July) 1947.

4. Harris, H. W.; Kilham, L., and Finland, M.: Local Streptomycin Therapy for Suppurative Otitis: Bacteriologic and Clinical Observations, Arch. Otolaryng. **49**:69 (Jan.) 1949.

This is a report on 30 cases of chronic suppurative otitis media with, in the majority, bilateral involvement of the ears, in various degrees of neglect, and the usual fetid otorrhea going on for months and years. The drum membranes were partially eaten up or totally absent, and the middle ear cavities were lined with granulation tissue. In some patients the carious ossicles could still be seen. There was one patient who, I suspected, had a cholesteatoma. One patient had acute mastoiditis, and one had chronic mastoiditis secondary to the chronic ear infection. The youngest patient was 2 years old and the oldest was 52. The duration of the disease was from five months to 40 years. History of the affliction dated mostly from childhood.

The preparation of the mixture was simple: 1 Gm. of the streptomycin and 200,000 units of the penicillin crystals were poured into the standard 1 ounce (28 Gm.) bottle of the glycerite of hydrogen peroxide with urea and then shaken well. This massive dose of the antibiotics was used so that the known development of resistant strains of the organisms would be avoided.

In the office, on the patient's first consultation, I just clean the ear canal with dry cotton pledgets and then prescribe the mixture, with instructions to the patient to put five drops into the ear four times a day and not to clean the ears, fearing that reinfection may be introduced by use of septic cotton pledgets at home. At the end of the first week the patients were told to come back for examination and cleaning of the ear canal. Surprisingly, there were no irritations or signs of sensitivity, a complication which I feared at first. The middle ear cavities were only moist or practically dry, and, above all, the fetid odor which had plagued these patients for months and years had disappeared. The granulation tissue lining the middle ear regressed to the extent that it appeared smooth, and in some cases signs of early epithelization were shown. The two patients with mastoidal involvement were, of course, hospitalized, and penicillin and streptomycin were administered parenterally. The patient with the secondary acute mastoiditis recovered fully after ten days in the hospital, and the ear became perfectly dry. In the patient with the chronic mastoiditis the ear became dry, but there was a residual tenderness over the mastoid area. The mother refused surgical intervention in this case.

In the second week, all the ears examined were dry, except in one case in which the prescription was refilled, and here the ear also became dry after a month. The mixture was not refrigerated to maintain the potency.

No ear drops have given me more satisfactroin than the mixture of glycerite of hydrogen peroxide, streptomycin and penicillin in the treatment of chronic purulent otitis media. Although these 30 cases are not many and therefore not conclusive, I believe that this is another step toward efficient therapy of chronic otorrhea.

SUMMARY

Thirty patients with chronic purulent otitis media were treated with a mixture of glycerite of hydrogen peroxide, streptomycin and penicillin crystals. After 14 days of treatment all the ears were dry except in one patient, whose ear dried after a month, and two patients with mastoidal involvement, who received streptomycin and penicillin parenterally besides the topical application of the described mixture.

DIRECT LARYNGOSCOPY AIDED BY A NEW LARYNGOSCOPE "STABILIZER"

LIEUTENANT COLONEL NORMAN E. KING
MEDICAL CORPS, UNITED STATES ARMY

To expose the larynx directly in the majority of cases is not a difficult procedure, but to maintain exposure manually for an extended period, whether the patient is locally prepared or under general anesthesia, soon becomes most fatiguing to the hand and wrist of the operator. This is particularly true in teaching institutions, where the intralaryngeal structures and such pathological conditions as may be present have to be demonstrated to the interns and residents. It is further a great handicap to the resident to have to take a quick look over the operator's shoulder and get a distorted view of that which is being demonstrated. With the above in mind, I have devised what I propose to call a "laryngoscope stabilizer" (fig. 1) which can be easily attached to any of the standard laryngoscopes and which will maintain the scope in any desired position, thus giving the operator the free use of both hands.

The end result is that the operator may take the necessary time, and in a relaxed position, to examine the larynx properly and to carry out the necessary procedures indicated. I feel that many cases of early carcinoma have been missed because the operator in maintaining exposure with one hand may be placed under just enough physical stress to keep him from taking the biopsy specimen at the proper site. A few millimeters away from the lesion in any direction can mean the difference in diagnosis.

Anesthesia cannot be overlooked as one of the most important phases of laryngoscopy. Too often an unsatisfactory operation can be attributed to the inadequate preparation of the patient or to inappropriate or inadequate anesthesia. Complete relaxation of the patient must be obtained, and in many cases this can be accomplished only with use of a general anesthesia.

The routine followed at this Army General Hospital for adults has been so satisfactory that I feel a description of it should be included here.

One hour before operation, 1½ grains (0.10 Gm.) of pentobarbital nembutal® is given by mouth, and ⅛ to 1/6 grain (8 to 10 mg.) of morphine combined with 1/150 grain (0.40 mg.) of atropine is given hypodermically.

Twenty minutes before operation, the throat is sprayed lightly with 10 per cent cocaine solution, with the tongue held well forward. This is repeated every five minutes for three times. Just before the patient is placed on the operating table, a few drops of 10 per cent cocaine solution is either dropped onto the vocal cords or applied by means of a laryngeal applicator.

Curare is given intravenously and very slowly until the patient has difficulty in raising his head from the table. At this time voice changes are usually noted. Sixty to 80 units is required. After five minutes, 2.5 per cent thiopental (pentothal®) sodium is given intravenously, very slowly, until the lid reflex is abolished and there is relaxation of the masseter and neck muscles. Oxygen is given through a tube in the nose.

The head rest which is a part of the table is placed in position. This elevates the occiput approximately 4 inches (10 cm.) from a line with the shoulders. The head and neck are then extended so that the chin points straight upward. An

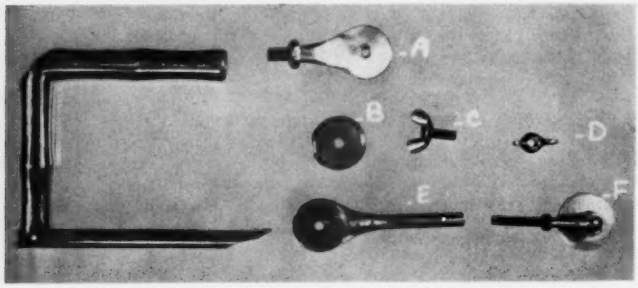


Fig. 1.—Dismantled laryngoscope attachment: *A*, short arm which screws into the handle of the scope; *B*, a thin bronze washer which fits between the heads of the two arms, *A* and *E*, to produce a friction lock; *F*, an aluminum plate ball and socket joint which screws into *E* and may be adjusted as desired.

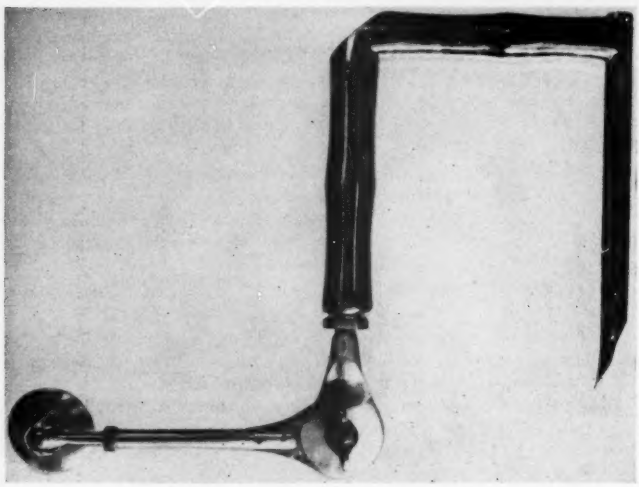


Fig. 2.—The assembled stabilizer attached to the laryngoscope and ready for use.

assistant to hold the head is not needed. The scope is then inserted in the usual manner and the anterior commissure brought plainly into view. The long arm of the "stabilizer" is then brought down on the manubrium and the friction lock slightly tightened. This type of lock has a great advantage in that it can be broken

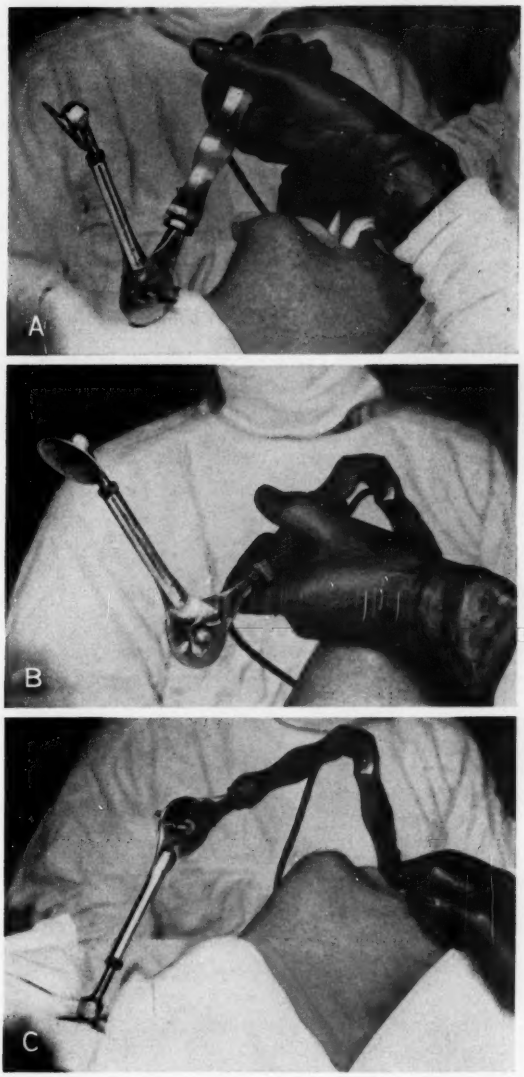


Fig. 3.—The method of using the stabilizer. *A*, the scope with the stabilizer attached is introduced into the pharynx; *B*, the epiglottis is elevated; *C*, the anterior commissure has been exposed and the long arm of the stabilizer brought down on the sternum with the right hand, fixing the scope in position.

by the patient without trauma and easily and quickly by the operator should anesthesia become too light.

This attachment, as shown in the figures, has been used at this hospital for over a period of six months with complete satisfaction. It is being presented not as a substitute for the now available one piece self-retaining laryngoscope but more to bring to mind the fact that the ordinary laryngoscope can be converted into a self-retaining one by a very simple device. It is true that the lighting in these scopes has not been satisfactory; however, this defect has been overcome at this hospital by placing a duplicate light carrier and tube on the opposite side, thus producing dual distal lighting.

SUMMARY

A new laryngoscope "stabilizer" which converts the ordinary laryngoscope into a self-retaining one has been described. The scope, which had only one light carrier, has been converted into one with dual distal lighting by adding another carrier tube on the opposite side.

The routine followed at this Army General Hospital in the performance of laryngoscopy has been outlined.

Captain Gaines K. Palmes, Army of the United States, chief of anesthesia at this Army General Hospital, assisted in the preparation of this article, and Mr. John Hudachek, an employee of the hospital, constructed the attachment.

FULL LUMEN INFANT BRONCHOSCOPE

ROBIN P. MICHELSON, M.D.
SAN FRANCISCO

Jesberg [1] stated in 1941 that the bronchoscopic examination of young infants presents an unusual risk because of the anatomically small glottis and subglottis. The hazard is further increased by inflammatory swelling of these regions. He further stated that the then existing bronchoscopes fit the glottis too snugly and often could not be passed without force. Accordingly, he and, a short time later, Holinger [2] developed distally lighted bronchoscopes of smaller outside diameter which, nevertheless, preserved a good working lumen. The development of both instruments was dependent on a smaller bulb, and both men used light carriers.

The instrument described here has an even larger lumen, owing to the elimination of the light carrier. Instead, two insulated "hair wires" are buried in the wall

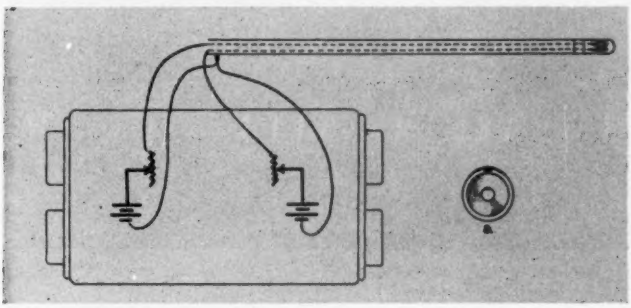


Fig. 1.—Diagram of circuits and of cross section (*a*) of bronchoscope tube, showing electrical conductors buried in the wall.

of the bronchoscope tube so that they do not project either to the inside or to the outside (fig. 1). Two distally placed "grain of wheat" lamps are provided. These lamps are on completely independent circuits, and thus illumination is maintained even if one lamp should fail during instrumentation.

From the Division of Otolaryngology, Department of Surgery, Stanford University School of Medicine.

Presented at the annual session of the American Academy of Ophthalmology and Otolaryngology, Oct. 11, 1949, Chicago. The instruments in the illustrations were presented as new.

1. Jesberg, S.: Baby Bronchoscopes, Arch. Otolaryng. **33**:88-89 (Jan.) 1941.

2. Holinger, P.: New Infant Bronchoscope and Esophagoscope, Arch. Otolaryng. **33**:431-432 (March) 1941.

The instruments shown are of the same outside dimensions as a popular standard 3 mm. bronchoscope (fig. 2).

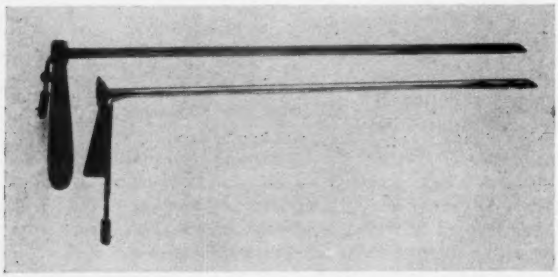


Fig. 2.—Standard 3 mm. bronchoscope (above); 3 mm. bronchoscope of new type (below).

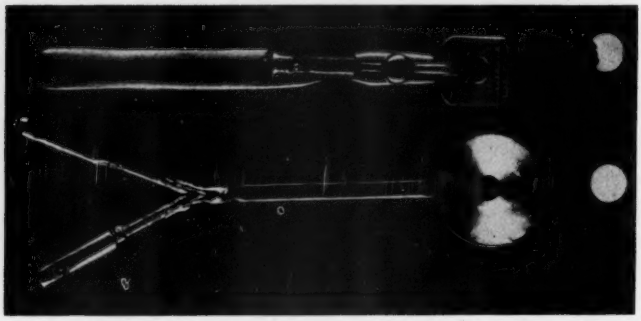


Fig. 3.—End view showing double connector. Light circles are actual photograph of equally illuminated lumens.

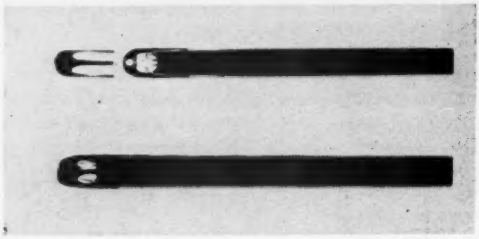


Fig. 4.—Tips of the new type 3 and 4 mm. bronchoscopes.

The elimination of the light carrier in the new instrument provides a lumen fully as large as the next larger size standard bronchoscope. In figure 3 are illustrated the 3 mm. sizes. Thus, more forceps space is attained. In figure 4 are shown the 3 and 4 mm. bronchoscopes.

As can be seen, the lamps are partly protected on the outside by a small removable cap, which is held in place by a small set screw. To change the lamps, a small "hollow" ground forceps should be used that fits the base of the lamps. With some patience and dexterity they are readily replaced. The instrument should be kept in good mechanical repair by the operator to prevent exposed parts from becoming foreign bodies.

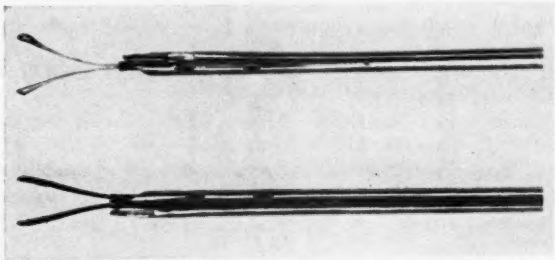


Fig. 5.—Side view of the 3 and 4 mm. bronchoscopes, with standard Jackson forceps inserted in 4 mm. tube.

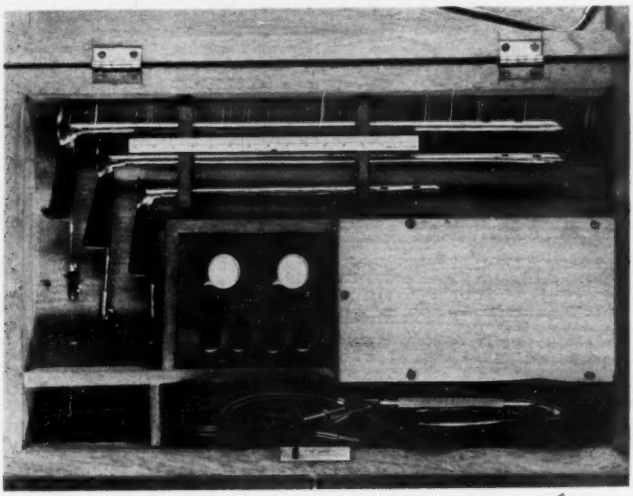


Fig. 6.—Carrying case, cords, dual battery box and set of three bronchoscopes, including size for newborn.

On the inside the glass envelops are protected by a thick dorsal lip, and the socket also slightly overhangs the lamps so that an instrument passed through the scope cannot come in contact with the glass. On the outside only a small area of glass comes in contact with soft tissue.

Since the development of this instrument it has been used successfully by four bronchoscopists for various cases, including foreign bodies, and so far no difficulties

have been encountered. Three of the patients were newborn infants, the smallest of which weighed 4 pounds 12 ounces (2,155 Gm.). In one case it was used to aspirate blood and clot from the tracheobronchial tree of an infant delivered by cesarean section, because attempted aspiration with a catheter had failed. In this instance the blood on the bronchoscope did not seriously hamper light or visibility (fig. 4).

SUMMARY

A new full lumen infant bronchoscope is described with the following improvements:

1. The light carrier is eliminated, and insulated conductors buried in the wall of the tube are substituted.

2. Maximum lumen is preserved for minimum outside diameter. Only the bulbs project slightly to the outside and inside of the tube.

3. Dual, distally placed illumination is provided, with independent lighting circuits.

240 Stockton Street.

SPECIAL NOTICE

For the general information of indexers, catalogers and library personnel with reference to the listing of the new title of this journal, we advise that the *Quarterly Cumulative Index Medicus* policy be followed. The *Quarterly Cumulative Index Medicus* with its volume 49 (January-June 1951) will list this journal under the new title, so that the letters A. M. A. will be included as an integral part of the title. For the completion of volume 48 (July-December 1950) the *Quarterly Cumulative Index Medicus* will continue to use the old title, without adding the designation A. M. A.

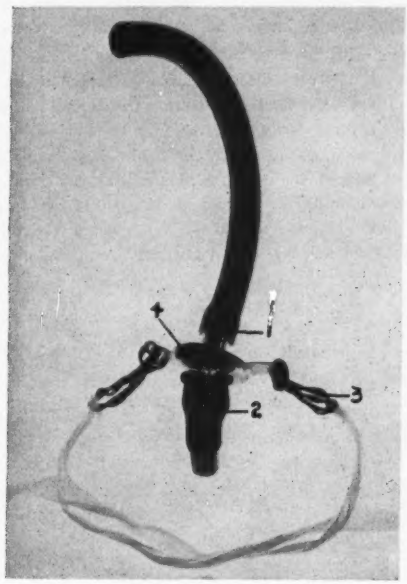
CORRECTION

The American Board of Otolaryngology will hold its examination in The John Marshall Hotel, Richmond, Va., not in the Roanoke Hotel, as was indicated in the November 1950 issue, page 842.

TRACHEAL STOMA WATER GUARD

JOSEPH R. RONGETTI, M.D.
NEW YORK

The obvious danger to the patient who has undergone laryngectomy of exposure to water has been obviated by a simple device designed, in the main, by a patient of mine.



Water guard.

C. H., 70 years of age, was first seen in September 1948 with a two month history of hoarseness. Laryngeal examination revealed neoplastic infiltration of the posterior portion of the left cord with involvement of the left arytenoid cartilage. Biopsy showed this to be a grade 1 epidermoid carcinoma. Laryngectomy was performed on October 13, and the patient made an uneventful recovery with minimal scarring and an excellent stoma.

The patient has always enjoyed robust health, and soon after the operation he resumed his usual preoperative routine with the exception, of course, of swimming and boating, both of which he previously enjoyed immensely.

After discussion with me concerning the new arrangement of his breathing mechanism, he finally evolved this simple apparatus which will allow a laryngectomized patient to breathe while standing in water up to the level of his external nares. With this apparatus he has been able to swim in 5 feet (1.5 meters) of water and now can also indulge in his powerboat hobby without fear of drowning. The other, more essential, advantages are that he can take tub baths or showers without fear of aspiration of water.

The apparatus consists of a one piece tracheotomy tube with an external extension, to which is attached fairly stiff ½ inch (1 cm.) rubber tubing 7 inches (18 cm.) in length (fig., *1*). The stoma is made water-tight by covering the internal portion of the tube in sleevelike manner with a rubber nipple, the tip of which has been cut off (fig., *2*). The most ingenious part is the incorporation of rubber bands in the tape (fig., *3*), to allow for constant equal traction about the neck. (This feature might well be used in our regular tracheotomy tube tapes.)

The force of pull with this type of traction results in a tilting of the tube so that the upper flange of the tracheostomy tube presses into the neck above the tracheostomy mouth. To relieve this pressure a rubber cushion is attached to the inner surface of this upper flange (fig., *4*).

When in actual use the end of the rubber tube is held snugly in the lips while the patient breathes through the nose. In this manner, even with submersion, the patient may keep his lung dry by holding his breath and closing off the posterior nasal passage by contracting his soft palate. When not in active use, the semistiff tubing rests against the cheek ready for immediate use in case of emergency.

25 Fifth Avenue.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

FUNCTIONAL EXAMINATION OF HEARING

ALFRED LEWY, M.D.
SHERMAN I. SHAPIRO, M.D.
AND
NORMAN LESHIN, M.D.
CHICAGO

THE PAST year has shown an increase in articles covering hearing tests of various kinds. Much of this material has been highly technical research in the mechanics and the physiology of hearing, which does not lend itself to abstracting. The contributions from the Scandinavian countries have been notable. Finland deserves special mention. The interest in aural rehabilitation continues to grow, as evidenced by the number of reports found in the literature.

TESTS

Interpretation of Hearing Tests.—Guild [1] mentions the use of hearing tests and their interpretation in nonmedical situations: in requirements for military enlistments and assignments as well as in educational assignments by school administrators to special classes or schools. These tests do not take into consideration the causes of poor hearing. Hearing tests and their interpretation are used in designing apparatus in modern telephonic and radio communication systems and in phonographs and in the taking of motion pictures as well as in architectural acoustics. The most familiar example of their nonmedical use is in the manufacture of hearing aids. Since the time of Bezold, the pure tone audiometer is the only new apparatus for tested hearing. The other test procedures, such as that with tuning forks, the Weber, the Schwabach and the Rinne test, date well back into the Nineteenth century. These tests with suitable masking can quickly classify a hearing impairment as to type and, usually, subtype. The cause can be determined only by a careful history and physical examination. All the elaborate technic and time-consuming tests described in the literature give very little added information to change one's decision as to the diagnosis and treatment, if any, indicated.

Guild does not wish to give the impression that he is opposed to the use of any but the simple hearing tests. He believes that a clear distinction should be made between tests for research purposes and those for clinical purposes. Tests that cannot be interpreted with reasonable certainty in terms of causative lesions have no definite clinical usefulness. The information gained is simply a statement of the kinds of hearing defects found by the tests made and is merely a description and not an interpretation of hearing tests. The reluctance of most clinical otologists to make these time-consuming, elaborate, refined, precise-measurement type of tests of

1. Guild, S. R.: Interpretation of Hearing Tests, Arch. Otolaryng. **49**:431 (April) 1949.

various aspects of hearing function is justified by the paucity of interpretation of proved medical value. Guild says that this situation constitutes a challenge to to investigators.

Clinical Reliability of Bone Conduction Audiometry.—Carhart and Hayes [2] reviewed a series of 250 cases selected from the records of the Aural Rehabilitation Program at Deshon General Hospital to determine the clinical reliability of bone conduction audiometry. This statistical investigation was made primarily to determine test-retest reliability of the method used in response to the criticism made by otologists and audiologists that the method possesses two limitations. The first is a lack of validity, or inadequacy, of the norms for bone conduction because of variations introduced, such as differences in skull structure and positioning of the vibrator; the second limitation is the doubtful reliability between test and retest measurements, owing to positioning, vibrator pressure and variations in retest measurements.

Two series of audiograms were compared, an initial one and a second one, both done with the same audiometer, approximately a month apart, with the same working technic and with reasonable thresholds on at least three frequencies by both air and bone. Any case in which a psychogenic or a central factor was present was ruled out. Three types of commercial audiometers were used routinely, the Western Electric 6B, the Sonotone 20 and the Maico D5. An auxiliary unit actuated by the audiometer was used with the Maico audiometer for the bone conduction determinators made with that instrument. All bone oscillators were of the hearing aid variety. The authors found that in the group as a whole the general level of hearing did not change between the first and second tests and that the data were adequate for the purposes at hand. Standard deviations for the air conduction data were somewhat larger than for the corresponding bone conduction measurements.

It can therefore be assumed that bone conduction measurements may be as good as those for air conduction thresholds when appropriate precautions are taken in testing. Low but positive parallelism between air and bone conduction measurements characterized test-retest shifts in threshold. The inherent error of pure tone audiometry varied somewhat with frequency, but the reliability of threshold for 1024 cycles per second emerged as inferior in both modalities of stimulation. The reliability for pure tone thresholds is partially dependent on the audiometer used. A comparison of results obtained with two different audiometers revealed significant superiority for one instrument by both air and bone conduction.

Carhart and Hayes emphasize that this study does not deal with threshold validity but deals mainly with the relative reproducibility of air and bone thresholds. They conclude that bone conduction measurements whose precision is clinically acceptable may be anticipated whenever proper control of test conditions is maintained.

Quantitative Examination by Air Conduction with Struycken Tuning Forks.—This article is an extensive one on Zakrzewski's [3] method of determining percentage of hearing loss by using the Struycken set of tuning forks, which, he claims, are the best ones made in that they give a constant decrement of the sound. After reviewing the modern and older physiological principles applying to hearing and

2. Carhart, R., and Hayes, C.: Laryngoscope **59**:1084 (Oct.) 1949.

3. Zakrzewski, A.: Otolaryng. polska **1**:68, 1947.

sound, the author states that the proper method is to calculate the percentage of hearing loss in decibels with relation to the whole range of hearing field for the respective frequency. With this purpose in mind he determined for every fork, using an electroacoustic method described by Lucke,[4] the initial amplitude as well as the initial and fixed decrement; this determination enabled him to show the fixed decrement and the time of sounding of the overtones.

However, since the records of the 250 decibel fork were lost (the investigation was begun in 1938), the author used another method, apparently only acoustic, in which the decrement was measured at distances of 10 and 5 cm. from the end of a brass pipe 29.5 cm. long. This procedure was done because, he asserts, the method used in England is open to error because the measurements are made at a too small distance from the pinna. The percentage loss is calculated by comparing the loss in seconds between the ideal sounding time of each fork and the time the patient hears it, with the damping constant obtained by the author. In order to save lengthy calculations, the author drew up a table indicating the percentage loss of hearing for every fork of the Struycken set at five second intervals.

For calculating the decrement in various Struycken tuning forks and transforming the duration in terms of decibel loss, Lumio and Arni[5] construct an audiogram similar to the usual audiometer graph, with quite uniform results. The calculations require the services of an acoustic physicist, but once the decibel value of the duration of hearing for each fork has been established the resulting graph runs very close to the one obtained on the audiometer. The forks cost much less and are more easily transportable.

[*Reviewers' Note.*—Each set of forks would probably have to be individually calibrated.]

Halm[6] has made audiometric comparisons of the maximal intensity of the sound of tuning forks. The maximum intensity of forks (the make is not mentioned) of 64, 128, 256, 512, 1024, 2048 and 4096 cycles per second were respectively 26, 46, 58, 62, 64, 72 and 80 decibels above threshold, as determined on the basis of the Stenger experiment.

Examination for the Fowler Recruitment Phenomenon.—In his paper, read before the Paris Larynogologic Society, Hennebert[7] presented a simple method of testing for recruitment. After commenting on the interesting phenomenon, first reported by Fowler in 1946, he states that one of the reasons that the test has not been more popular is that in the original technic it was essential for the patient to have one good ear and one "bad" ear so that loudness comparisons could be made. Recently Békési constructed a self-continuous registering sweep audiometer in which the patient presses a button when he hears the sound and releases it when he doesn't hear it; in this procedure not only is an audiometric curve given, but patients vary in the rapidity with which they record their perceptions of the frequencies, according to the type of deafness present. Hennebert's method is quite simple. He makes a very rapid test of the patient, beginning with the lowest intensity for each frequency and increasing it at the rate of 10 decibels per second. Then

4. Lucke, E., cited by Zakrewski.[3]

5. Lumio, J. S., and Arni, P.: Acta oto-laryng. **37**:71 (Feb.) 1949.

6. Halm, T.: Orvosi hetil. **90**:29 (Jan. 9) 1949.

7. Hennebert, M.: Ann. d'oto-laryng. **66**:219 (April-May) 1949.

he carefully makes a slow audiogram. If there is no recruitment, the difference between the two tests can be quite enormous—as high as 20 decibels. If there is recruitment, the difference is small—5 decibels or 0. The audiogram taken rapidly will be quite similar to the one taken slowly. A number of audiograms are presented in the article.

A simple method for monaural testing of the recruitment phenomenon is described by Luescher and Zwislocki.[8] With the new Békési audiometer, the difference between the increasing and decreasing intensity evaluation is taken at, say, a 40 decibel loudness. The normal difference of threshold on increasing and decreasing the loudness is 10 to 16 per cent, but in inner ear deafness it is much less. A reading of less than 8 per cent at 30 decibels over threshold is evidence of nerve deafness.

Dix, Hallpike and Hood[9] contribute their article "Observations upon the Loudness Recruitment Phenomenon, with Especial Reference to the Differential Diagnosis of the Internal Ear and Eighth Nerve." Loudness balance tests were carried out in 30 cases of Ménière's disease and in 20 cases of degeneration of the eighth nerve due to neurofibroma and other varieties of space-occupying lesions of the cerebellopontile angle.

Loudness recruitment was present and complete in all 30 cases of Ménière's disease and was absent in 14 of the 20 cases of nerve degeneration; in the remaining six it was present but incomplete. Loudness recruitment was shown to be present in disorders of the end organ of hearing and to be characteristically absent in disorders of the cochlear nerve fibers. The latter finding sharply controverts existing views on the neurological mechanism of recruitment.

The practical and theoretical significance of the experimental results are discussed. The new hypothesis advanced in explanation of these results is based on recent experimental work on the physiology of hearing and on the known pathology of the cochlea and the eighth nerve.

The condition of sudden deafness in 18 patients seen in the ear department of the Sundby Hospital (Copenhagen) over a period of 15 years was analyzed by Rasmussen.[10] Of the group, 15 were women and three were men. Their ages ranged from 19 upward; eight were under 40 and 10 were over. Of 14, follow-up observations could be made. In all the patients the deafness was unilateral, the right ear in eight, the left in 10. In three, the acoustic function alone was affected, in 15, the vestibular also.

Of the 14 patients for whom follow-up observation was made through the years, one recovered almost normal hearing and two gained minor improvement. The vertigo gradually subsided in all but recurred in one patient after six years. Usually the first symptom noticed was a loud "singing," associated with or followed shortly by deafness; a little later, vertigo with nausea and vomiting were experienced.

In six cases Fowler's recruitment test was tried in three frequencies. In four the reaction was negative; in one it suggested a disorder of the internal ear and in one, a conduction deafness. The fact that the lesions were supposedly of the inner ear and that in two of the four cases there was no bone conduction raises the

8. Luescher, E., and Zwislocki, J.: Pract. oto-rhino-laryng. **10**:521, 1948.
9. Dix, M. R.; Hallpike, C. S., and Hood, J. D.: J. Laryng. & Otol. **52**:671 (Nov.) 1948.
10. Rasmussen, H.: Acta oto-laryng. **67**:65 (Feb.) 1949.

question of the diagnostic import of the Fowler recruitment test for nerve deafness. In one case the giddiness did not occur until 10 years after the deafness. On admission, in seven patients the spontaneous nystagmus was to the normal side, in two to the affected side and in two it was dependent on position. The reactions to the caloric and the rotation tests were elicited in 10 and absent in one of the 11 patients thus tested.

Rasmussen thinks that the cause is either vascular spasm leading to ischemia or neuritis of the eighth nerve in connection with arachnoiditis. In three cases with arteriosclerosis and hypertensive vascular disease the lesion may have been thrombosis of the internal auditory artery or its branches or hemorrhage into the labyrinth. In one case the possibility of vascular spasm was considered, and two cases supported the theory of neuritis of the eighth nerve.

In another article on the subject, Kobrak [11] attempts to explain the recruitment phenomenon of Fowler and other hearing phenomena on the basis of a dual function of the cochlear nerve, which he describes as developing from two sources, the saccule, which supplies the vestibulocochlear principle, and the cochlea proper. The cochlea principle proper, the "all or none law," is served by the subepithelial part; the cochleovestibular principle, the law of proportional potential, by the epithelial part.

Much of his argument is based on Saxen's work on clinical and histological examination and on electrophysiological experiments, which show two types of response, one following the "all or none law" as action potentials, the other following conditions proportional to the magnitude of the stimulus as distortion potentials.

Some Suggestions for Speech Reception Testing.—Harris [12] presents suggestions for those who wish to improve their technic for speech reception testing and, perhaps, to attempt their own standardization of one or more of the newer laboratory tests. The unreliability of the traditional free voice test is the random fluctuation of the over-all speech intensity. This variable can be controlled with the use of a sound level meter. A handy portable model meeting all the required standards can now be obtained. The meter is placed about 2 feet (61 cm.) away from the examiner's lips and slightly to the side. A group of patients with normal hearing standing about 15 feet (4.6 meters) away is first tested with a broad sample of speech so that they are just able to repeat the phrases. Their response is recorded as the average normal reading. A patient is now tested, and if he cannot hear the normal average recorded intensity of speech he is regarded as having an impairment of hearing. The tester then raises his voice until the patient responds correctly. The examiner repeats various samples of speech at this increased intensity until he is confident in the reliability of an average meter reading.

The hearing loss is determined simply by noting the difference in decibels between that reading and the average reading for persons with normal hearing taken under the same standard conditions. However, monitoring one's voice is very difficult, and speaking either very softly or very loudly tends to distort the speech sounds. This distortion can be eliminated by substituting a high fidelity communication system between tester and patient and by locating the patient in

11. Kobrak, F.: J. Laryng. & Otol. **63**:395 (July) 1949.

12. Harris, J. D.: Some Suggestions for Speech Reception Testing, Arch. Otolaryng. **50**:388 (Oct.) 1949.

another room so that he cannot hear speech directly from the tester's lips. The system can be a simple, inexpensive one, and a diagram showing the essential features is presented in the article. With this system one has the added advantage of varying speech intensity at the patient's ear. To approach laboratory precision, the phonograph or recorded voice should be used. This use has the added advantage of stability of test-retest results, of permitting analysis of the record word by word and of enabling the tester to turn over the testing with confidence to assistants. In addition, individual words of any particular sample of speech sounds may be rendered very nearly alike in intelligibility. This likeness, or homogeneity of intelligibility, cannot be achieved with either free or monitored live voice because of the wide difference in the relative intelligibility of words, even though all words are produced at the same physical intensity.

Equal intelligibility of test words is, however, a very desirable and necessary requirement for word lists used for speech reception testing. This intelligibility is not accomplished entirely in the available lists used at the present time. It has been secured by Harris by treating the lists with a recording procedure. He first selected a group of words which formed an adequate sample of English speech sounds. These sounds were recorded with high fidelity. The relative intelligibility of each word was then determined and a rerecording then made compensating for each word so that the relative intelligibility of all words tends toward an average. The technic for this procedure is described. It is hoped that some day some of the phonetically balanced lists, suitably rerecorded and standardized, will be commercially available.

Leisti [13] presents a method of using speech audiograms. He uses an Amplivox audiometer on which the volume is regulated and calibrated on the regular decibel scale. The ears are examined separately. The patient repeats words in groups of three and receives a plus mark only if all three words are repeated correctly. If any one is wrong he receives a minus mark. The percentage of plus marks at each intensity is noted, and these values are diagrammed so that the abscissa denotes the sound volume, the ordinate, the percentage.

In an article entitled "On Rendering Hearing Tests by Speech Homogeneous" by Sjöström,[14] the same subject is discussed in Finnish.

The Relation Between Hearing Loss for Specific Frequencies and the Distance at Which Speech Can Be Identified.—Curry [15] made a study of 156 ears to determine whether there is a definite relationship between hearing loss for specific frequencies and the distance at which the spoken voice can be identified. This study dealt only with the relationship of individual frequencies to the total speech score as contrasted to previous studies in which the average decibel loss was used. The type of patients were those usually found in a speech and hearing clinic, with an age range of from 16 to 72 years. None were able to hear the average whisper at 1 inch (2.5 cm.), but all responded to the spoken voice at a distance between 1 inch and 20 feet (6 meters). A specially constructed room was used, and the voice used was that of an adult male whose average pitch level had been previously determined to be 131 cycles. The test was carried out by the tester's pronouncing

13. Leisti, T.: Acta oto-laryng. **37**:256, 1949.

14. Sjöström, L.: Acta oto-laryng. **37**:253, 1949.

15. Curry, E. T.: Ann. Otol., Rhin. & Laryng. **58**:33 (March) 1949.

digits while moving slowly away from the subject and determining the greatest distance at which the subject could identify the digits. Within the limits of this study for the 156 ears, the individual audiometer frequency values, either air or bone conduction for decibel loss, indicate little statistical association with the spoken speech score. The correlation for the tentative standard procedure for evaluating the percentage loss of hearing, as advocated by the American Medical Association, indicates that it is not statistically certain that there was any degree of association with the spoken speech score.

Comparison of Threshold for Speech, Word and Sentence Tests.—Breakey and Davis [16] made a comparison of thresholds for speech, word and sentence tests with monaural and binaural listening and between listening in a free field and under a receiver with the same material. A group of 10 normal persons was tested, and the results were compared with the results of tests of 10 hard of hearing persons. The latter group was composed of four subjects with predominant conduction deafness, two with mixed deafness and four with serious nerve involvement. The special equipment, as used at the Central Institute for the Deaf, is described as well as the method used for calibration. The auditory test no. 9, the spondee words and sentences of the Psycho-Acoustic Laboratory test no. 13 were used for testing. Field listening showed a mean threshold for the two tests lower by 2.88 ± 0.47 decibels than receiver listening. The threshold for test no. 12 by receiver listening was 6.64 ± 0.73 decibels higher than for test no. 9 for the normal subjects. The corresponding difference for the hard of hearing group was 5.31 ± 0.46 decibels. For the binaural tests the two ears of the normal listeners were not equated for differences in sensitivity. Nevertheless, for receiver listening the normal subjects showed significant advantages of 2.55 decibels for binaural listening over the average of all monaural thresholds and of 1.4 decibels over the mean threshold for the better ear. The group with impaired hearing showed a mean advantage of 3.25 decibels for binaural listening over monaural when the listeners' ears were equated in sensitivity. The mean threshold of the normal group for phonetically balanced monosyllabic word lists was about 11 decibels higher than their mean threshold for test no. 9.

Reliability and Validity of Monitored Connected Discourse as a Test of the Threshold of Intelligibility.—For articulation testing, Falconer [17] used an everyday newscast transcribed from the radio network. The electroacoustic apparatus consisted of a turntable, an amplifier, attenuators and a calibrated headphone. The advantages claimed for the test are speed (two minutes), interest for the listener and lack of mental fatigue, high face validity, reliability and negligible learning effects. The chief disadvantage is the subjective nature of the end point.

Hearing Evaluation by Low Conversational Voice Tests.—Gloring [18] made special experiments with the low conversational voice tests in the auditory rehabilitation unit at the Walter Reed General Hospital in order either to dispose of or to substantiate the many discrediting reports made concerning this test. A special speech tunnel was constructed and equipped with a monitoring system, which included a microphone, an amplifying unit and an output meter. The test

16. Breakey, M. R., and Davis, H.: Laryngoscope **59**:236 (March) 1949.

17. Falconer, G. A.: J. Speech & Hearing Disorders **13**:369 (Dec.) 1948.

18. Gloring, A.: Ann. Oto., Rhin. & Laryng. **58**:394 (June) 1949.

was made with the usual low conversational voice first and then repeated with the microphone held close to the mouth, thereby monitoring the voice to reach a constant level during the test. The same examiner was used for both tests and was one who had considerable experience with the test. One hundred and seventy-three tests were made. The results show that the low conversational voice test has inherent faults which make it impossible to arrive at even approximate hearing thresholds and that the clinical variations shown are due, for the most part, to these faults.

Gloring concludes that according to all laws of acoustics the test is in no way practical or even admissible. If one further introduces the factors of different rooms and varied ambient noise levels, it can easily be understood why the results are so inconsistent. The writer hopes that this work, which confirms other opinions, will help to abolish "this worse than useless method of testing hearing."

Present Status of Objective Hearing Tests.—Kobrak [19] presents the shortcomings of the commonly used subjective hearing tests, namely, the acoustic pupillary reflex, the general acoustic muscle reflex and the cochleopalpebral reflex test. The acoustic pupillary reflex is a small contraction of the pupil followed by a slow pupillary dilatation in response to an introduction of short, strong sounds into the ear. The literature shows that even under the most favorable conditions the reflex is visible in only 33 per cent of persons with normal hearing. The general acoustic muscle reflex is the contraction of various body muscles to loud unexpected sounds. It is a remnant of the "fear reflex" generally found in animals. In infants it is manifested by movement of the head, contractions of the rump muscles and extension of the arms. This special sensitivity in the infant diminishes to the adult stage at the age of 3 or 4. In the adult stage it is not simply a reflex but is influenced also by surprise and fear. It is not easily used in cases of malingering because voluntary inhibition is possible, except when complicated methods are used and when only special muscle groups are used, as in ink writing. Quantitative measurements cannot be obtained. This test is widely used for determination of function in infants.

The cochleopalpebral reflex is the most important acoustic muscle reflex. It is found in 90 to 95 per cent of normal adults. High frequencies between 2000 and 4000 given as short, sudden, shrill sounds are the most favorable stimuli. This reflex, like the other acoustic muscle reflexes, is subject to voluntary cortical inhibition, and the test for it should be given as a surprise.

Kobrak presents the stapedius muscle reflex test as the only one that can be used for quantitative tests in man. The reflex contractions of the stapedius muscle are due to acoustic stimulation of the cochlea. This reflex can be observed under proper experimental conditions and also in cases in which there is a perforation, especially in the posterior superior quadrant, or in which the drum membrane has been destroyed. With slight magnification, as provided by a Siegel speculum, sound can be conducted in either the same or the opposite ear, and the contractions of the stapedius tendon will be seen to last exactly as long as the duration of the sound. This reflex is a true reflex independent of the cortex with stimulation of one side followed by simultaneous contraction of both sides. It is not influenced by fear, surprise or attention and can be demonstrated repeatedly. It disappears in

19. Kobrak, H. G.: Ann. Otol., Rhin. & Laryng. **57**:1018 (Dec.) 1949.

deep general anesthesia. This reflex occurs usually at 40 to 50 decibels below the threshold of hearing; so fairly good hearing is necessary to elicit it. Fixation of the stapedius muscles by adhesions may also arrest the motility of the stapedius tendon. In some patients with intact drum membranes it may be possible to see this reflex by producing artificial transparency of the membrane. This procedure may be accomplished by massage of the drum membrane with a mixture of glycerol, water and potassium iodide. If the procedure will be successful, transparency begins immediately. If gentle massage of three minutes does not make the examination possible it is discontinued and no further attempts are made. The stapedius tendon reflex is visible in more patients than otologists realize. It can be used as an objective hearing test when it is visible in infants or patients too young to give reliable responses in hearing tests, to demonstrate cochlear function in psychiatric patients and to demonstrate the function in malingering.

A Study in Objective Audiometery with the Use of a Psychogalvanic Response.—Bordley and Hardy [20] present a technic for the achievement of objective audiometry by psychogalvanic skin resistance. It requires no conscious cooperation from the person being tested and gives promise of special usefulness in diagnostic work with very young children, psychogenic deafness and malingerers. A description of the apparatus is given in detail. Skin resistance electrodes leading to the apparatus from the patient are placed opposite each other on the palm and dorsum of the hand or on the sole and instep of the foot. Shock electrodes are placed on the arm, leg or back and the stimulating current is regulated through the Harvard inductorium in circuit with the 6 volt dry cell battery.

The intensity of the shock can be graduated and changed at any time. The electrical changes vary with the activity of the sweat glands, so it is necessary to keep the patient warm during the test; if necessary, the patient is heated with infra-red lights until perspiration occurs. A single ear phone is held against the ear to be tested. (The test is performed with adults seated in a chair; children are placed on an assistant's lap, all facing away from the examiner.) A selected tone of high intensity is introduced into the subject's ear and is followed in four or five seconds by an electric shock of sufficient intensity to cause the patient some anxiety in anticipating the stimuli to follow. Skin resistance changes in response to stimulation occur about one and one-half seconds after the stimulus is given.

The subject is conditioned by the tester continuing to introduce the auditory stimulus at a high level followed by the shock until there is evidence of conditioning. When conditioning occurs the intensity of the tone is gradually diminished until the threshold is reached. After each response to the auditory stimulus the shock is repeated. When there is no change in skin resistance after auditory stimulation no shock is given, and this level is considered near threshold. Repeated readings are taken above and below the tentative threshold, as in routine audiometry, a shock always being given after each positive response but no shock given when there is no change in skin response. The procedure is repeated on other tones until the sound spectrum is satisfactorily explored. A patient may be conditioned after from two to 10 auditory stimuli followed by shock, and once he becomes conditioned to one tone he is conditioned to all tones audible to him. A complete test for a five tone threshold audiogram from 500 to 5000 cycles takes about an

20. Bordley, J. E., and Hardy, W. G.: Ann. Otol., Rhin. & Laryng. **58**:751 (Sept.) 1949.

hour. A group of audiograms are presented to show the practical application and reliability of the test. The writers emphasize the point that the technic is not free from difficulties. They found serious problems in the control of movements of the children and also difficulties from outside electrical interference. They hope, however, that the test offers a practical approach to the field of objective threshold audiometry.

Suggestive Procedure for Determining Auditory Acuity in Very Young Acoustically Handicapped Children.—Utley [21] reviews the various procedures that have been reported to determine the presence of hearing during the child's first year or two of life. The first three or four years of a child's life are critical and especially important to the child when speech and language are destined to remain dormant because of a hearing loss. It is imperative, therefore, that the hearing function be properly evaluated and that the parents be prepared as early as possible for the possibility of a hearing loss. Hearing can be tested in infants as early as the first few months of life. Froeschels, with the use of Urbantschitsch's whistles, found that infants react with the acoustopalpebral response. Some infants reacted by turning their heads or moving their eyes.

Utley mentions Ewing's work to determine the reaction of children of various ages to different sounds. During the first three months of life infants respond to percussion sounds more quickly than to voice. During the next three months voice gains over the percussion sounds. In the second half of the year infants begin to localize sound by turning the head and the eyes and react to voices and different meaningful sounds. During the second year single speech tests are suitable. Quiet speech attracts their attention more than loud speech. The groups of 2 to 3 year olds also react well to speech tests, and for the group of 3 to 5 year olds vocalization and whisper are the most effective form of stimuli. Pure tone audiometric tests are unsuitable for children of these ages.

To test the very young child, the auropalpebral reflex and involuntary movements of the body, head or eyes, in response to various startling sounds, may be the only means for determining the presence of hearing. In some cases it may be necessary to allow the child to familiarize himself and to become experienced with the noise makers before any kind of response can be elicited.

Some children with severe hearing impairment may not respond at all because of a lack of meaning of sound, and some, because of absorbed interest in play activities, may not give reliable responses or may respond only to an initial stimulus and tend to ignore repeated sound stimuli.

Instruments used for these tests are usually drums, tom-toms, tambourines, pitch pipes, horns, whistles, bells and squeaking toys. Hand clap and loud voice are also used. Slamming of doors, stomping of feet and dropping of articles are not suitable for testing, for these procedures produce vibrations with the sound. The approximate frequencies and intensities of the instruments for various distances were determined by Utley. For example, the sound of the tom-tom is 60 cycles per second, with an intensity of 88 decibels at 1 foot (33 cm.) and 76 decibels at 6 feet (183 cm.); that of tambourines, 300 cycles per second, 90 decibels at 1 foot and 80 decibels at 6 feet; that of a cowbell, 1560 cycles per second, 105 decibels at 1 foot and 80 decibels at 6 feet, and that of a squeaky doll, 2590 cycles per second, 70 decibels at 1 foot and 65 decibels at 6 feet.

21. Utley, J.: Eye, Ear, Nose & Throat Monthly **28**:590 (Dec.) 1949.

The articles of Ewing, MacFarlan, Dix and Hallpike and Keaster, all of whom use the so-called conditioned response technic in various procedures, are reviewed in Utley's paper.[21] The procedures enable one to determine the approximate amount of amplification necessary for the child to understand speech if the conditions of testing are controlled. The child who possesses a sufficient hearing residue to develop some speech should be given a speech reception test suitable to his age, and vocabulary objects, pictures or common expressions or commands may be used as test material. Special equipment for this type of test is necessary. Various methods for the objective method of testing hearing acuity without patient cooperation are also presented.

Michels and Rand used the galvanic skin response with the electroencephalograph as the instrument to record the response. Doerfler also used this procedure and found it a promising method for determining malingering, psychogenic deafness and hearing in very young children. Bordley, Hardy and Richter used an electrodermal technic, and Marcus and Gibbs used some nonspecific arousal response. A complete reference list to all these articles is in the review made by Utley.[21]

Testing for Psychogenic Deafness.—Leuscher [22] states that psychogenic deafness shows a difference limen of 20 to 40 per cent, which is two or three times that of normal, while the difference limen in diseases of the nervous apparatus is much smaller. The abnormally small values of the difference limen in deafness of the nervous apparatus, described by Békésy, Luescher and Zwislocki, seem to be characteristic of the peripheral receptor only, perhaps of only the sensory cells of the organ of Corti but not of the whole nervous apparatus of the ear.

Test for Paracusis.—Davidson [23] describes a simple objective test for paracusis. He has the patient stand with his back to the observer at the limit of accurate hearing distance. The background noise, which may be a running water tap or a Bárány noise apparatus, is then activated and the hearing distance of speech again measured. The observer must take care to maintain his voice constant in intensity. It is asserted that the improvement in hearing, when present, remains for five or six seconds after the background noise is discontinued. In eight of the nine patients with clinical otosclerosis, the results of the test have been positive. One patient with a negative response, a 61 year old woman, said that the paracusis had been present in her thirties but that she had not observed it lately.

Acoustic and Vestibular Barometry.—Jones and Edmonds [24] give a preliminary report of the effects on hearing caused by an increase or decrease in air pressure on the middle and inner ear structures. The apparatus constructed was a water manometer, ear plugs and a Western Electric 6 BP audiometer with a modified air conduction receiver. Thirty-two ears not operated on and eight fenestrated ears were tested. Two groups were tested. In group 1 ears 1 through 15 had no change in bone conduction hearing at threshold when tested with tones of both 256 and 1024 cycles and subjected to either positive or negative air pressure change. In group 2, ears 16 through 32 showed a change in hearing by bone conduction for these tones, resulting in an increase or decrease in the intensity of the threshold sound when the ears were subjected to either increased or decreased pressure.

22. Luescher, E.: Pract. oto-rhino-laryng. **11**:107, 1949.

23. Davidson, A. S.: J. Laryng. & Otol. **63**:462 (Aug.) 1949.

24. Jones, M. I., and Edmonds, F. C., Jr.: Ann. Otol., Rhin. & Laryng. **58**:323 (June) 1949.

Similar results were obtained with the 8192 bone conduction tone except for a smaller magnitude, possibly owing to the fatigue factor and also to the interference of vibratory pain and tactile sense, complicating the recording of pure hearing. In most cases when bone conduction at 1024 cycles is 30 or more decibels greater than the air conduction there is no change in the intensity of the sound with pressure variations. When it is less than 30 decibels the sound will probably vary in intensity. In most instances it will decrease until it is inaudible. This 30 decibel differential is critical and may indicate stapes fixation. When the sound is heard better by bone conduction in the ear opposite to the one being tested, namely "crossed hearing" after the sound becomes inaudible in the tested ear, it becomes audible in the opposite ear. In the air conduction tests changes in threshold hearing are noted when the pressure is varied, as in the bone conduction tests. Most patients report a decrease in the intensity of the sound, which returns later after a rest period.

Of the eight fenestrated ears, only two showed improvement, while in the other six hearing returned to the preoperative level. Of this group only one patient showed a change in the 1024 sound by air conduction when subjected to the pressure test. No changes for bone conduction sound following pressure variations were found in any of the severe cases. The authors conclude that a drum membrane and an ossicular chain are necessary for changes in hearing to occur with pressure changes. Further studies may establish the air pressure test as a test for stapes fixation in the ear not operated on. Vertigo did not occur in the 32 cases of ears not operated on but only in the two cases of ears operated on, which showed a definite postoperative hearing improvement. The pressure test may also be a test for patency of the fenestrum in the fenestrated ear.

Stapedioparalytic Phonophobia in a Deaf Ear.—Tschiassny [24a] reports a case of Bell's palsy in a deaf ear associated with paralysis of the stapedius muscle with a hypersensitivity for loud acoustic stimuli on the paralyzed side. This phenomenon, more commonly known as hyperacusis, the writer names phonophobia. It is elicited by introduction of a very loud stimuli to the affected ear to see whether a painful reaction occurs. Two factors are necessary for this phenomenon: an unimpaired sensitivity of the ipsilateral middle ear structures and an unimpaired cochlear function of at least one ear. Tschiassny suggests routine testing for the phonophobia in any case of Bell's palsy and whenever occupational or circumstantial exposure to potential acoustic traumatization calls for examination of the natural inner ear protectors. He also suggests that the described condition might be helpful as a diagnostic support in the symptomatology of otosclerosis and a warning signal in cases of latent dysfunction of the stapedius muscle. When the phonophobia is present it might be advisable to use some sort of a sound protector, especially when the ear is exposed to strong acoustic stimuli.

Functional Differentiation of Deafness.—Luescher [25] offers a new classification of the disturbances of the mechanical and the nervous apparatus, besides that of simple middle ear and inner ear deafness. Threshold values enable one to distinguish between middle ear and inner ear deafness, but not with certainty between

24a. Tschiassny, K.: Laryngoscope **59**:886 (Aug.) 1949.

25. Luescher, E.: Pract. oto-rhino-laryng. **10**:254, 1948.

mechanical and nervous disturbances. New methods are discussed for testing the nervous apparatus (loudness balance, fatigue and adaptation tests) and objective physical methods (impedance) for the mechanical apparatus.

A history of the development of the tests for measurement of the cochlear potentials, together with a complete bibliography, including their own tests and conclusions, are given by Hamberger, Hydén, Dahl and Nilsson.[26] The curve is characterized by a gradation curve with typical compression and typical changes in wave form. A discussion and comparison are included.

Hamberger, Hydén and Nilsson[27] experimented on guinea pigs, using the pinna reflexes and cochlear potentials (the correlation between cytochemical changes in the cochlear ganglion and functional tests after acoustic stimulation and trauma). These were registered after various periods following stimulation with 6000 cycles per second at 80 decibels for three hours. Up to 14 days no deviation was found from the controls after this acoustic stimulation. This result shows that the extensive chemical changes found in the nerve cells of the cochlear ganglion after the same acoustic stimuli (Hamberger and Hydén[28]) reflect a physiological process in connection with increased functional demands.

For the benefit of the acoustic physicists who are also mathematical physicists, attention is called to an article by Zwislocki-Mościcki,[29] in which the mechanics of the function of the cochlea are reduced to mathematical formulas and various theories of the physiology of hearing are discussed in this light. The 75 pages do not lend themselves to abstracting by a clinician.

Clinical Aspect of Perceptive Deafness (Nerve or Internal Ear Deafness).—Davis's[30] article treats of the various types of internal ear deafness from various causes. It is assumed that the lesion is of the cochlea, the auditory nerve or the center of hearing in the temporal sphenoidal lobe. Tinnitus and often vertigo are present in the early stages. When the lesion is unilateral, sound in the Weber test is lateralized to the good ear and the reaction to the Rinne test is positive. Other fork tests are described in detail. Patients require considerable increase in the strength of the signal to hear in the presence of noise. Exclusion of the possibility of other types of deafness and a clinical history are important. Cases of mixed deafness are most difficult to diagnose.

Labyrinthine tests are necessary to exclude the possibility of tumors of the eighth nerve and the cerebellopontile angle. The history is important. In meningitis the infection spreads along the auditory nerve or the aqueduct of the cochlea. Fracture of the posterior fossa through the labyrinth is usually fatal. Clinical types of deafness from injuries may result from actual structural damage or may be psychic or functional. Temporary concussion deafness may exist. Persistent noise trauma involves the hair cells of the organ of Corti. Ménière's syndrome is due to a

26. Hamberger, C. A.; Hydén, H.; Dahl, H. M., and Nilsson, G.: Acta oto-laryng., 1949, supp. 75, p. 114.

27. Hamberger, C. A.; Hydén, H., and Nilsson, G.: Acta oto-laryng., 1949, supp. 75, p. 124.

28. Hamberger and Hydén, cited by Hamberger, Hydén, Dahl and Nilsson.[26]

29. Zwislocki-Mościcki, J.: Acta oto-laryng., 1948, supp. 72, p. 70.

30. Davis, E. D.: J. Laryng. & Otol. **53**:144 (March) 1949.

glaucoma of the internal ear or increased pressure of venous or lymphatic circulation. Drainage of the semicircular canals or of the saccus endolymphaticus is known to relieve aural vertigo.

It is difficult to identify the saccus; one may open the dura instead. A hearing loss usually accompanies Ménière's syndrome. A loud noise or change of posture may excite an attack. The author prefers to call the attack "aural vertigo" so as not to frighten the patient. He believes that aural vertigo differs from that of intracranial origin but that stimuli from the cerebral cortex, especially during excitement, may "fire off" an irritable labyrinth.

Brunner states that the change in the endolymph may be vasomotor or toxic. Tumor is the only lesion of the nerve that can be diagnosed with certainty. Fowler's recruitment phenomenon is of diagnostic aid in certain cases of nerve deafness. Cerebral deafness can be recognized. Fibers pass from the nuclei in the floor of the fourth ventricle through the pons to the superior convolution of the temporal lobe. The vestibular nerve connects with the nuclei of the oculomotor nerves and sends fibers to the vermis and the cortex of the cerebellum. (No mention is made of the vestibulospinal tract—*Abstracter.*)

In senile deafness the patients are easily fatigued and find it difficult to follow rapid speech. Perhaps there are gaps which have to be filled in by context. Patients with psychic deafness do not listen, and hallucinations of hearing are common in cases of mental disease. The author has not obtained any specimens of the auditory nerve nuclei or the cortical center in cases of deafness, nor has he found any postmortem record of multiple sclerosis lesions thereof.

Further Statistical Study of Auditory Tests in Relation to the Fenestration Operation.—Thurlow and associates [31] report the results of the auditory tests in a second series of 55 young and middle-aged persons on whom the fenestration operation was performed. The tests were done before and a few months after operation and comprise pure tone audiometry: two tests for the threshold of speech, test no. 9 and the threshold of intelligibility for connected discourse, and a test for the maximum articulation score on phonetically balanced lists given at high intensity. The tonal adequacy index was calculated from these. The test-retest reliability of test no. 9, measuring hearing loss for speech, was very high, with a standard of error between 3 and 4 decibels. Fenestration caused no significant change in the maximum articulation score on the phonetically balanced test, if the test was given at a high enough intensity.

The maximum score on the phonetically balanced test varied with the clinical diagnosis, being highest in conduction deafness and lower when nerve involvement predominated. The results of pure tone audiometry averaged over the speech range correlated well with tests of hearing loss for speech but tended to underestimate the gain for speech immediately after fenestration by as much as 5 decibels. This situation is due to a relatively smaller gain at frequency 2896, which is not reflected in the threshold measurements for speech since the frequency is relatively unimportant for the understanding of easy words or for simple every day connected discourse.

31. Thurlow, W. R.; Davis, H.; Silverman, S. R., and Walsh, T. E.: Laryngoscope **59**: 113 (Feb.) 1949.

The phonetically balanced score at high intensity is a quite stable measure if it is initially 85 per cent or higher, but it is much more valuable below that initial point. The score on the phonetically balanced list at the intensity level of the threshold of intelligibility for connected discourse was about 25 per cent in the present series. The results of the auditory test compare very favorably with those of the past series of 161 cases reported a year ago. Test no. 9 proves to be the most reliable and generally satisfactory test for threshold of speech for the type of patient presented. The gain for speech and the improvement of the social adequacy index are not significantly related to the type of mastoid bone encountered or to the presence of a moderate amount of nerve deafness.

Audiometric Tests of Speech-Defective College Women.—Hogarty and Miller [32] tested 118 women enrolled in the speech clinic at Wellesley College (1946-1947) to determine their acoustic acuity. Fifty per cent had normal ears; 28 per cent had some deviation in one or the other ear; 18 per cent had some deviation in both ears, and 4 per cent were classified as having a subnormal ear or ears. If a 20 decibel loss had been used as a norm, 81.4 per cent could be considered to have normal ears. The high percentage of good hearing found is a good omen for corrective speech procedures, but the fact that some students had a hearing loss indicates the advisability of a hearing conservation program with suitable medical and educational follow-up procedures.

Practical Application of Clinical Audiometry.—Warshaw [33] describes the hospital audiometric department and equipment and the technic of group testing and of individual testing with the pure tone audiometer. He calls attention to nerve fatigue, echo and distortion of various kinds and suggests means of detection of these as well as methods to avoid confusion with an already existing tinnitus by an interrupted or rhythmical tone. He mentions the fallacy of using masking when testing bone conduction. He describes special tests for malingering and states that repeated tests at intervals of days should be consistent within 5 decibels.

A pronounced unilateral deafness produces a parallel graph of about a 40 decibel difference; masking the good ear gives a different graph. A sudden loud sound in a stone deaf ear may cause an involuntary reflex response. A sudden switching note and a masking tone from ear to ear in a patient with good hearing will cause confusion and conflicting answers.

Warshaw also describes the technic of fitting hearing aids and of advising patients. He contends that the human element must receive as much or more consideration than the mechanical. Tests must be carried out by trained persons of proper personality with tact and endless patience. The tester should understand the psychology of the deaf, the handling of deaf-mute children and the rudiments of lip reading. He should have a knowledge of anatomy, physiology and diseases of the ear and the causes of deafness. He should have an understanding of the basic principles of acoustics of the ear, the physics of audiometers and hearing aids and their adjustments as well as an understanding of medical and professional etiquette. The author says that only 66 per cent of hearing aids are finally retained by patients.

32. Hogarty, I. E., and Miller, V. R.: J. Speech & Hearing Disorders **13**:4 (Dec.) 1948.

33 Warshaw, B.: J. Laryng. & Otol. **62**:721 (Dec.) 1948.

[*Reviewers' Note.*—Stevenson, as noted elsewhere in this review, states that if lipreading is learned 90 per cent of the hearing aids are retained.]

Two Room Audiometry Setup for the Otologist's Office.—Work[34] describes a compact two room audiometry setup for the otologist's office, which was patterned somewhat after the plan used by the Army for its rehabilitation work. Details of the construction and equipment are given in the paper. The advantages of such a setup are that it is less distracting for the patient and easier for the technician as well as that the tests can be done with greater accuracy and flexibility. Such a room can also be used for speech reception technics, which are more and more becoming a necessary part of complete audiometry evaluation, and in it malingering tests also can be carried out with greater accuracy.

A Practical Soundproofing Method.—Veckman's[35] article on the problem of the extraneous noise level as applied to audiometry is stimulating. Veckman states that soundproofing equipment had been developed by industry for its own needs and can be used in the field of otology so that the subject under examination can be placed in conditions in which the level of surrounding noise is practically "reduced to zero."

While a soundproof room is ideal theoretically, there are two objections to it in practice: One objection is that the patient placed in a completely noiseless environment experiences a strange feeling, which gives rise to a psychic disturbance in a person already disturbed about his hearing, and the other is the considerable cost and inconvenience of installing such a room in an office. It was the recognition of these facts which led to the development of the supposedly noiseproof telephone type of receiver, which is closely applied to the patient's head.

The author states that no matter what type of rubber lining is used to separate the receiver from the ear which is being examined, it is impossible to keep sound from traveling across the cranial bones to the opposite ear and thus influencing the result of the examination. The use of masking in the other ear with noise is open to the same objection, since the sound will reach the ear under examination.

[*Reviewers' Note.*—These facts are well known to students of hearing tests in this country, although they are at times minimized by enthusiasts for audiometry.]

Mention is made of an arrangement by Aubry whereby a jet of air is used through the audiometric head band to mask the other ear, but no discussion of this arrangement is given.

As a substitute for soundproofing, the writer offers an arrangement that, he believes, insures "practical silence" and brings about freedom from noise for the ear under examination without at the same time doing anything in any way to the opposite ear. This arrangement is achieved by means of a wooden cabinet (2.5 by 5 by 2.5 meters) with a projecting cone. The interior of the cabinet is lined with several thicknesses of wool surrounding a loud speaker, which faces the projecting cone. The tip of the cone has a rubber ring, against which the ear under examination is placed. The wire leading from the audiometer to the loud speaker runs on the inside of the cone. In this way bone conduction is minimized, for the receiver is not in direct contact with the ear and the ear can be pressed tightly against the conical opening of the box without distorting the result of the examination. The

34. Work, W. P.: Laryngoscope **59**:454 (May) 1949.

35. Veckman, J. L.: Bull. Acad. roy. de méd. de Belgique **13**:36 (Jan.) 1948.

author used an indirect method of measuring the amount of noise elimination achieved by this means and found it to be up to 70 decibels and, of course, more in defective ears; this method he considers ample for all practical purposes. A diagram of the apparatus is attached, but no audiograms, normal or otherwise, with this instrument are shown in the article.

Functioning of the Air Cell System of the Mastoid Process in Audition.—MacDonald [36] shows in his study that the air cell system of the mastoid process acts as a sound absorber to prevent sound waves from building up in the middle ear and interfering with the excursions of the drum membrane, thereby distorting transmitted sound waves. These air cells also absorb sound to a variable degree when a bone conduction test is done, and erroneous readings and interpretations may result from this factor. After simple mastoidectomy or fenestration, sound in the Weber test will always lateralize to the ear operated on, provided the cochlear function is good, owing to the lessened absorption of sound waves following destruction of many air cells of the mastoid process. This phenomenon will occur whether the fenestration is patent or not, so long as the cochlear function is good. The author believes that the hearing threshold of patients undergoing the fenestration operation will never permanently approach the normal level unless the procedure is revised to preserve the air cells in the mastoid process.

TRAUMA AND GENERAL DISEASES

Will Noise Damage Hearing?—Grove,[37] as a member of the subcommittee on industrial noise, of the American Academy of Ophthalmology and Otolaryngology, presents some of the salient facts of this subject and recommendations for consideration. Hearing impairment resulting from exposure to excessive noise in industry is now designated as occupational deafness. Exposure to excessively loud sounds over a long period of time results in impaired hearing. The louder the sound and the longer the period of exposure, the greater the impairment. Not all ears are equally susceptible. Although various reports differ, it is believed that noise of 90 decibels or less can be disregarded as having any effect on the hearing function.

Some factors other than intensity and pitch which must be considered are total length of exposure, the length of exposure per period, whether the sound stimulus is continuous or interrupted, the length of the interruptions, the type of space and environment, the age of the worker and previous aural disease. There is no form of therapy effective for recovery of hearing loss due to noise. Prevention is the only method of attack. It is suggested that pilot plants be established in some industry in which noise is a special health factor. In these plants the entire problem could be studied and protective and preventive measures worked out. Some of these plants have already been set up. Careful preemployment hearing examinations should be made of every person who is to be placed in an operation in which the noise level exceeds 90 decibels.

For preventive measures three steps should be taken: first, redesigning of buildings and machinery to permit less noisy operation; second, the transfer or

36. MacDonald, P. C.: Functioning of the Air Cell System of the Mastoid Process, Arch. Otolaryng. **49**:447 (May) 1949.

37. Grove, W. E.: Tr. Am. Acad. Ophth. **53**:574 (May-June) 1949; Will Noise Damage One's Hearing? J. A. M. A. **140**:674 (June 25) 1949.

removal of a worker with especially noise-sensitive ears to some less noisy operation, and, third, the reduction of injurious noise at the ear of the worker by occlusion of the external auditory canals by suitable obturators or ear plugs. Grove also presents the medicolegal aspects of this subject. Loss of hearing from exposure to noise of an injurious level is an occupational disease. Occupational disease is now compensable in 33 states, in Washington, D. C., Hawaii and Puerto Rico. In order to avoid abuses to both employer and employee, proper precautions and preventive measures should be taken, and members of the medical profession should play their part in seeing that this is done.

Theilgaard [38] speaks of the value of testing the organ of hearing with special reference to noise prophylaxis. Industrial noise is usually between 1000 and 3000 cycles. The noise of airplane motors is usually below 1000 cycles per second, and frequently causes a defect, usually temporary, at 4096 cycles per second. After continued exposure of the ear to this range the defect may be irreversible. The defect occurs at this frequency even if vibrations between 3000 and 6000 cycles per second are cut out. The author experimented with 11 ears of seven persons with normal hearing between 20 and 30 years of age in a silent chamber, with five minutes of exposure to 100 decibel intensity. Individual differences were found to be up to 43 decibels, and between the two ears of the same person the difference ranged to 32 decibels. It would be illusory to record the element of fatigue in a person on the basis of one frequency. The reactions of any individual subject may be different at different times.

Hazards of Intense Sound and Ultrasound.—Davis and associates [39] report the effect of ultrasonic vibrations on hearing. Sound waves at ultrasonic frequencies, namely, those above 15,000 cycles per second, differ from audible sound waves particularly in their shorter wavelength, in forming relatively sharp sound shadows and in being attenuated more rapidly as they travel through air. They are of practical importance in being present in the aerodynamic noise of aircraft and in the exhausts of jet engines. Two observations were made in the sound room at the Aero Medical Laboratories. One of the authors with a hearing loss over 6000 cycles per second was placed in a sound field of 153 decibels at 10,000 cycles per second for five minutes and again for 35 minutes in a field of 1450 cycles per second at 151 decibels. In neither case was his hearing affected. Another of the authors with normal hearing was placed in a sound field of 6500 cycles per second with an average intensity of 159 decibels for five minutes; he experienced severe pain and a small rupture near the center of the drum membrane, with hearing depressed somewhat below 1000 cycles per second and unmeasurable above 8000 cycles per second. Normal hearing returned within a few days, with some high tone loss persisting after 14 weeks. The authors conclude, however, that it is not the ultrasonic vibrations per se that constitute a hazard to hearing but rather the high intensities. Sound above 120 decibels stimulate the sense of touch and may cause temporary and possibly permanent hearing loss. Levels above 140 decibels are painful to the ear, and exposures to such levels without special protection should be avoided. A good rule is to avoid any sound intense enough to cause pain.

38. Theilgaard, E.: Acta oto-laryng. **37**:347 (Aug.) 1949.

39. Davis, H.; Parrack, H. D., and St. Eldredge, D.: Ann. Otol., Rhin. & Laryng. **58**:732 (Sept.) 1949.

A clinical survey into the effect of turbo-jet engine noise on the service personnel of the Royal Air Force was made by Dickson and Watson.[40] They report that minor degrees of deafness were complained of but that the results of clinical examination, including audiometric tests, were negative. "No adverse effect on the morale of those under review was detected during the survey, despite the fact that they were aware of the published accounts in the popular press of so-called 'supersonic sickness'."

Hearing at Low Oxygen Partial Pressure.—Halm [41] investigated the symptom complex of altitude sickness of air force personnel. The threshold of stimulus is about 2,500 meters. The organism remains unaltered below this altitude. A compensation takes place under 4,000 meters. At 6,000 meters the symptoms become manifest, and about 7,000 meters is the zone of death. The reactions depend on the rate of rising, but individual variations are possible. Besides the various general symptoms, the functions of the sense organs decrease at the same time as psychic functions. Hearing examinations were performed in a low pressure chamber and with the application of low oxygen partial pressure. The hearing capacity could be influenced by the obstruction of the equalization of air in the tympanic cavity. The decreased conduction of tones in the rare atmosphere has a lesser practical significance. To reduce the high rate of experimental errors a method of hearing examination was elaborated in normal atmosphere with the help of Békésy. Variable amounts of oxygen and nitrogen gases were given by inhalation through a well fitted air-tight mask. According to the oxygen concentration of the gas mixture, the receptive altitude could be read on a scale. A series of 100 patients were examined by this method, and the disturbing side effects were eliminated. A decrease of up to 30 decibels was shown in the middle and high frequencies during the inhalation of air with a low oxygen concentration. Island-like hearing losses were never observed. The tolerance against lack of oxygen is individual, and the hearing condition suffers according to it. (This abstract was made by Nicholas Torok, M.D.)

Hearing Deficiencies Caused by Carbon Monoxide Generator Gas.—In the university clinic at Helsinki, Finland, Lumio [42] examined 700 persons who had been exposed to gases. Two hundred and sixty-three suffered from carbon monoxide poisoning; 401 had been exposed in their occupation but were symptomless, and 36 had been exposed to other gases. Their hearing was examined for response to speech, whisper, tuning forks and the monochord. Audiometric and vestibular tests were made, as well as complete medical and laboratory examinations.

Of those showing other evidence of carbon dioxide poisoning, 78.3 per cent had a hearing deficiency. Of those without definite evidence of poisoning, 26.7 per cent had a hearing deficiency. The typical carbon dioxide type of hearing loss was found in 67.7 per cent. The threshold values were good in the lower frequencies but dropped evenly and steeply between 1000 and 2000 cycles and continued downward from then on. They were bilaterally symmetric, as was the bone conduction. These values were evident also for 14 per cent in whom no other signs of poisoning could be definitely demonstrated. Only 47.9 per cent complained of their deafness; 44.5

40. Dickson, E. D. D., and Watson, N. P.: J. Laryng. & Otol. **63**:276 (May) 1949.

41. Halm, T.: Orvosok lapja **4**:37 (Jan.) 1948.

42. Lumio, J. S.: Acta oto-laryng., 1948, supp. 71, p. 11; 1948, supp. 74, p. 150.

per cent had typical disturbances accounted for only by carbon dioxide poisoning. Only 5.2 per cent were entirely free from symptoms. Follow-up examination showed improvement in 26.7 per cent, all among the milder cases; 10.7 per cent returned to normal. The author concludes that on this basis carbon dioxide poisoning is apparently often responsible for hearing impairment.

For the otological determination of trauma to the head, Escher [43] presents audiograms in 20 cases of head injury without fracture. In most of these cases a sharp dip of about 4096 cycles per second was shown in the audiogram. However, the author states that this peculiar defect may be present without trauma.

Audiometric Tests in Some Nervous Disorders.—Sambataro [44] studied 18 cases of neurosyphilis, 12 cases of multiple sclerosis and 3 cases of optic atrophy due to poisoning by methanol, with respect to otological findings. The Weber, Schwabach and Rinne tests, as well as otoscopic examination and audiometric studies, were made of all patients. A constant diminution was noted for high tones in all the cases of neurosyphilis, although only two patients complained of unilateral hearing impairment; the low tones varied from 17 per cent to 46.5 per cent. There was an inconstant loss of high tones in some of the cases of multiple sclerosis, while in two of the three cases of optic atrophy due to methanol poisoning a considerable impairment for the same tones was shown. A lack of agreement was noted between these results and those obtained by the classic and older tests with tuning forks. The audiograms are included in the article.

Acoustic and Vestibular Function in Blood Dyscrasias.—Negri [45] made a study of 35 patients with various blood dyscrasias, mainly leukemia and malignant lymphogranuloma, with relation to acoustic and vestibular function. There were 19 cases of leukemia; in 42 per cent of these there were characteristic auditory findings, consisting of high tone loss, with sparing of the low tones. There was a reduction in bone conduction, as indicated by the Schwabach test. In the cases of malignant lymphogranuloma these was a greater percentage (77 per cent) of hypofunction of this type. Except in one case, both auditory and vestibular hypofunction were symmetrical. No definite and constant correlation seems to exist between the seriousness of the dyscrasia and the gravity of the cochleovestibular trouble, whereas the latter condition appeared to be more frequent in the initial stages of the disease. A number of audiograms are included in the article.

Repercussions of Vascular Disorders of the Internal Ear.—Riesco [46] presents a study of 51 cases of hypacusis and/or tinnitus in patients between the ages of 50 and 70, in whom no evident cause was present. Vascular examinations were made of all these patients, and the patients were classified in the following groups according to the results: In the first group were 20 patients without vascular alterations; in the second, 17 with minor vascular alterations, which the physician considers normal with relation to age, and in the third, 12 with advanced vascular alteration to the extent that all were, and had been, under medical treatment for an extended period. With respect to symptoms, they were further classified as follows: 13

43. Escher, F.: Pract. oto-rhino-laryng. (supp. 1) **10**:1, 1948.
44. Sambataro, C.: Arch. ital. di otol. **59**:89 (March) 1948.
45. Negri, M.: Arch. ital. di otol. **60**:58 (Jan.-Feb.) 1949.
46. Riesco, J. S.: Rev. otorrinolaring. **8**:3 (March) 1948.

with hypacusis without tinnitus; 1 with tinnitus and without hypacusis, and 37 with hypacusis and tinnitus. The patient with tinnitus and without hypacusis was neurotic, and the condition was considered to be of psychopathic origin.

The audiometric curves were, in general, those of nerve deafness with loss of hearing for high tones. The author feels that a relationship can be established between the audiometric curves and the type of pathologic condition which should exist as a cause. Thus, if only the basal coil of the cochlea is involved, fairly good hearing for voice (5 meters) is still present; if extensive involvement of the basal coil is combined with moderate involvement of the medial spiral (on which are received the tones from 512 to 2048 double vibrations), the spoken voice is heard with difficulty at 5 meters. Finally, if the atrophy of the basal spiral is nearly complete, intense in the medial and partial in the apical (on which are found the tones varying from 16 to 512 double vibrations), the patients have difficulty in understanding words spoken from a distance of 40 cm.

The prognosis of senile hypacusis or presbycusis is not bad because the atrophic and degenerative cochlear processes which cause them never become complete in the three spirals of the cochlea; the degenerative processes respect, in a major or minor degree, the apical and medial spirals. This observation refers to hypacusis of perception in middle or advanced age and not to hypacusis of sudden onset, in which case the prognosis is bad.

In analyzing his material, the author found himself unable to differentiate, on the basis of symptoms and cochlear findings, patients with and without circulatory alterations, and he arrived at the conclusion that these are similar in both groups.

He also believes that the cochlear alterations of old age are the result of atrophic and degenerate neuritis due to wasting and are not caused by circulatory disturbances. Furthermore, he believes that no differentiation clinically or pathologically can be made between presbycusis and progressive hypacusis of youth or that there is a degeneration of Corti's organ when the condition is due to trauma.

Auditory Examination of a Group of Ten Patients with Hypertensive Vascular Disease.—Mosser's [47] paper was presented jointly with the preceding one at a meeting.[46] The ages of the patients in this series ranged from 36 years upward, and the patients demonstrated a progressive scotoma for high tones similar to that found in presbycusis.

In the discussion that followed the reading of the two papers, the general opinion favored the occurrence of cochlear changes due solely to vascular changes, but it was suggested that a study of young persons with spasmodic circulatory conditions rather than a study of those in whom chronic vascular changes were present was necessary to throw more light on the subject.

Congenital Defects Following Maternal Rubella.—Abel and Van Dellen [48] made a survey of 84 babies born of mothers having rubella during pregnancy. Eighty-seven per cent of the babies born of mothers with rubella during the first trimester were abnormal; 42 per cent in the second, and probably none were abnormal born

47. Mosser, J.: Rev. otorrinolaring. **8**:19 (March) 1948.

48. Abel, S., and Van Dellen, T. R.: Congenital Defects Following Maternal Rubella, J. A. M. A. **140**:1210 (Aug. 13) 1949.

of mothers with rubella in the third trimester. Of this series, 14 babies, or 16.5 per cent, had deafness, 12 per cent of which occurred in babies whose mothers had rubella in the first trimester.

Postmeningitic Complications with Particular Reference to Otological Sequelae.—Grove and Fox [49] made a statistical study of 323 cases of epidemic cerebrospinal (meningococcic) meningitis with special reference to the complications. The mortality rate in this series was 17.7 per cent. A questionnaire was sent to the 268 survivors and was answered by 178. Twenty-two patients complained of postmeningitic deafness, and 11 reported for a clinical examination during 1948. Three of these had total bilateral deafness; two had a unilateral total loss with normal hearing in the other ear; in two there was a unilateral loss with a marked impairment in the other ear, and the remaining two had only a small amount of residual hearing in both ears. From this examination and the results reported by others, the authors feel that the hearing defect caused by epidemic cerebrospinal meningitis is usually permanent and sometimes progressive.

Relative Auditory Aphasia.—Saltzman and Ersner [50] report a case which they term relative auditory aphasia, in which speech deafness became superimposed on a severe hearing impairment as the result of neurological and psychophysiological factors. Persons with this condition are able to hear amplified tones, but the meaning of words seems to be lost to them. Their audiograms do not differ from those who are able to understand loud speech perfectly well. In profound deafness the understanding of speech frequently deteriorates to a greater degree than the pure tone acuity. This situation is especially true in people of advanced age. Slow cerebration is also found in arteriosclerotic encephalopathy. Also, persons who are profoundly deaf and deprived over a prolonged period of the benefit of conversing with their fellow men will lose the meaning of sound, and this loss will result in a stunting of their vocabulary. An important factor also is the psychogenic overlay, which is most frequently present.

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE AND REHABILITATION OF THE AMERICAN MEDICAL ASSOCIATION

As of Dec. 1, 1950

Aurex Model F
Aurex Model H
Mfr. Aurex Corporation
1117 North Franklin Street
Chicago 10

Beltone Mono-Pac
Beltone Harmony Mono-Pac
Beltone Symphonette
Beltone Mono-Pac Model M
Mfr. Beltone Hearing Aid Company
1450 West Nineteenth Street
Chicago 8

Cleartone Model 500
Cleartone Regency Model
Mfr. American Sound Products, Inc.
2454 South Michigan Avenue
Chicago 16

Dysonic Model 1
Mfr. Dynamic Hearing Aids, Inc.
1042 Atlantic Avenue
Brooklyn 16

Electroear Model C
Mfr. American Earphone Co., Inc.
10 East Forty-Third Street
New York 17

49. Grove, W. E., and Fox, M. J.: Ann. Otol., Rhin. & Laryng. **58**:771 (Sept.) 1949.
50. Saltzman, M., and Ersner, M. S.: Eye, Ear, Nose & Throat Monthly **28**:523 (Nov.) 1949.

Gem Model V-35
Gem Model V-60

Mfr. The Gem Ear Phone Co., Inc.
50 West Twenty-Ninth Street
New York 1

Maico Atomeer
Maico UE Atomeer
Maico Quiet Ear Models G & H

Mfr. The Maico Company, Inc.
21 North Third Street
Minneapolis 1

Mears Aurophone Model 200
1947-Mears Aurophone Model 98

Mfr. Mears Radio Hearing Device Corp.
1 West Thirty-Fourth Street
New York 1

Micronic Model 101 (Magnetic Receiever)
Micronic Model 303

Mfr. Micronic Company
727 Atlantic Avenue
Boston 11
(See Silver Micronic)

Microtone T-3 Audiomatic
Microtone T-4 Audiomatic
Microtone T-5 Audiomatic
Microtone Classic Model T9
Microtone Model 45

Mfr. The Microtone Company
Ford Parkway on Mississippi
St. Paul 1

National Cub Model (C)
National Standard Model (T)
National Star Model (S)
National Ultrathin Model 504
National Vanity Model 506

Mfr. National Hearing Aid Laboratories
815 South Hill Street
Los Angeles 14

Otarion Model E-1
Otarion Model E-1S
Otarion Model E-2
Otarion Model E-4
Otarion Models F-1 and F-2

Mfr. Otarion, Inc.
159 North Dearborn Street
Chicago 1

Paravox Models VH and VL (Standard)
Paravox Model XT ('Xtra-Thin)
Paravox Model XTS ('Xtra-Thin)
Paravox Model Y (YM, YC and YC-7)
(Veri-small)

Mfr. Paravox, Inc.
2056 East Fourth Street
Cleveland 15

Radioear Permo-Magnetic Multipower
Radioear Permo-Magnetic Uniphone
Radioear All-Magnetic Model 55
Radioear Model 62 Starlet

Mfr. E. A. Myers & Sons
306-308 Beverly Road
Mt. Lebanon
Pittsburgh 16

Silver Micronic (Magnetic and Crystal)
Models 202M and 202C

Mfr. Micronic Company
727 Atlantic Avenue
Boston 11
(See Micronic)

Silvertone Model 103BM

Mfr. National Hearing Aid Labs.
815 South Hill Street
Los Angeles 14

Distr. Sears Roebuck & Company
925 South Homan Avenue
Chicago 7

Silvertone Model M-35

Mfr. Micronic Company
727 Atlantic Avenue
Boston 11

Distr. Sears Roebuck & Company
925 South Homan Avenue
Chicago 7

Silvertone Model P-15

Mfr. W. E. Johnston Mfg. Company
708 West Fortieth Street
Minneapolis 8

Distr. Sears Roebuck & Company
925 South Homan Avenue
Chicago 7

Solo-Pak Model 99

Mfr. Solo-Pak Electronics Corp.
Linden Street
Reading, Mass.

Sonotone Model 600
Sonotone Model 700
Sonotone Model 900
Sonotone Models 910 and 920
Sonotone Model 925

Mfr. Sonotone Corporation
Elmsford, N. Y.

Super-Fonic Hearing Aid

Mfr. American Sound Products, Inc
2454 South Michigan Avenue
Chicago 16

Televox Model E
Mfr. Televox Mfg. Company
1307 Sansom Street
Philadelphia 7

Telex Model 22
Telex Model 97
Telex Model 99
Telex Model 200
Telex Model 1700
Mfr. Telex, Inc.
Telex Park
Minneapolis 1

Tonemaster Model Royal
Mfr. Tonemaster, Inc.
400 South Washington Street
Peoria 2, Ill.

Trimm Vacuum Tube Model 300
Mfr. Trimm Distributors, Inc.
400 Lake Street
(P. O. Box 489)
Libertyville, Ill.

Unex Model A
Unex Midget Model 95
Unex Midget Model 110
Mfr. Nichols & Clark
Hathorne, Mass.

Vacolite Model J
Mfr. Vacolite Company
3003 North Henderson Street
Dallas 6

Western Electric Model 63
Western Electric Model 64
Western Electric Models 65 and 66
Mfr. Western Electric Co., Inc.
120 Broadway
New York 5

Zenith Model 75
Zenith Miniature 75
Mfr. Zenith Radio Corporation
6001 West Dickens Avenue
Chicago 39

All of the accepted hearing devices have vacuum tubes.
(Accepted hearing aids more than five years old have been omitted from this list for brevity.)

TABLE HEARING AIDS

Aurex (Semi-Portable)
Mfr. Aurex Corporation
1117 North Franklin Street
Chicago 10

Precision Table Hearing Aid
Mfr. Precision Electronics Co.
5157 West Grand Avenue
Chicago 39

Sonotone Professional Table Set Model 50
Mfr. Sonotone Corporation
Elmsford, N. Y.

HEARING AIDS

The Hearing Aid in Mixed Deafness.—Saltzman and Ersner [51] studied a group of 12 patients with mixed deafness with reference to the selection of a hearing aid. They found that some air receivers produce a very disturbing echoing of the patient's own voice, with distorted sounds. Which aid will do this is unpredictable. This distortion is apparently due to some of the frequencies being perceived by bone conduction and others by air conduction. The echoing of the patient's own voice can be attributed to a difference in phase relationship between the two routes through which the sound travels. They found, also, that a bone receiver usually does not give good speech reception in this type of deafness. Mixed deafness, however, is especially prone to the recruitment phenomenon so that a minimal amount of amplification frequently restores serviceable hearing. The audiograms are less helpful in predicting a good fit for this than for other types of deafness.

51. Saltzman, M., and Ersner, N. S.: The Hearing Aid in Mixed Deafness, Arch. Otolaryng. **50**:249 (Sept.) 1949.

Hearing Aids for Deaf-Mutes and the Partially Deaf.—Scuri,[52] who is professor of phonetics at the otorhinolaryngological clinic of the University of Naples, classifies, from the educational aspect, the hard of hearing and the deaf into three divisions: deaf-mutes, deaf-mutes with some ability to perceive sounds and partially deaf children. He believes that hearing aids, multiple or single, are of no value for deaf-mutes in either category, who are best educated in special schools, but that they have considerable value for partially deafened persons.

A description of modern hearing aids and their fitting is given by Pothoven,[53] of Groningen, Netherlands. After describing the mechanism, he deplores the fact that the fitting is largely in the hands of the laity. Fitting of hearing aids should belong to the otologist for the reason that it is not impossible to damage the hearing of the patient, especially in cases of deafness with the recruitment phenomenon, which is an important factor to consider and which the manufacturers have not yet allowed for. To avoid further injury to patients with recruitment deafness, special devices are necessary, such as peak clipping or compression amplification. He is strongly in favor of the individually fitted ear tip (which is practically universally used in the Netherlands), for the bone conduction tip requires a 45 volt battery and does not amplify above 2,000 cycles. The latter types should be restricted to patients with discharging ears. In general, the best results have been obtained with aids giving a flat response in the speech range or with a slight emphasis on the higher frequencies. These results are in accordance with the experiments of Davis and Stevens.

Theoretical and Practical Aspects of Hearing Aids.—Caussé and Gondet[54] present a detailed article on the physical characteristics and performance curves of modern hearing aids. The performance curves are taken from the published reports of the Physical Council of the American Medical Association. (No mention is made of the source of the hearing aids used in the author's own experience, which is admittedly small, but apparently these aids were either of American or of British manufacture.) The author considers that the ideal horizontal curve of amplification is impossible of attainment because of the difference in amplification of various tones of the scales, but he feels that the most desirable aid should come as close to this uniform amplification as possible. He finds that it is exceptional for a patient not to be substantially benefited by a hearing aid. Nor is it true, he states, that the greatest benefit comes to those with the most profound deafness. Deaf-mutes are helped only when they have been subjected to auditory reeducation. In contrast to most American writers, he feels that bone conduction receivers are definitely preferable to air conduction receivers in many instances. A number of audiograms are presented.

REHABILITATION

Hearing Reeducation Without the Use of Hearing Aids.—Browd[55] presents a report of hearing reeducation without the use of a hearing aid in an unselected group of 50 cases of impaired hearing of more than several years' standing. The

52. Scuri, D.: Arch. ital. laryng. **57**:129, 1949.

53. Pothoven, W. J.: Acta oto-laryng. **36**:296, 1948.

54. Caussé, R., and Gondet, I.: Ann. d'oto-laryng. **65**:117 (March-April) 1948.

55. Browd, V. L.: Hearing Reeducation Without the Use of Hearing Aids, Arch. Otolaryng. **59**:511 (May) 1949.

rationale for this procedure was based on the same principle of benefits gained with reeducation with the use of a hearing aid. The normal ear can distinguish 1,500 different pitches and 325 degrees of loudness, a third of a million tones in all. The usefulness of such an ear depends on its ability to detect small differences in the sound patterns rather than on its ability to hear faint and distinct sounds. Too many sounds in the impaired ear appear to be alike, and as a result there is a tendency to disregard these sounds, with a subsequent increased loss of hearing power. The interpretation and discrimination of these sounds are the important feature of reeducation of hearing and speech, which is the most important and most frequently heard of the day's sounds.

The speaker is seated face to face with the patient at a distance at which a conversational tone can just be comfortably heard, the speaker covering his mouth with a 5 by 8 inch (12.7 by 20 cm.) white card held at a 45 degree angle in front of it. Simple sentences concerning a single topic are delivered, and the patient is told to repeat them. If they are correct he is told so; if not, the card is removed and the sentence repeated. This procedure is carried on for several minutes and repeated the following day and daily thereafter, with additional improvement noted each time. The improvement is due to the discovery made by the patient of the many vague, incomplete or unfamiliar speech patterns becoming adequate and taking on a full meaning.

Further improvement is obtained by correction of misinterpreted speech. Monosyllabic word lists of a length sufficient to include all the speech sounds of English are delivered in a manner similar to that described. When certain speech sounds are found to be regularly mistaken for others by the patient, they are then incorporated in individually prepared word lists in such a manner as to set off their differences in pitch, loudness, impulse and duration. After a satisfactory degree of understanding is attained at the original distance, the distance is increased and the voice is lowered or contact is made more difficult. Eventually, the procedure is presented in situations which the patient originally stated were most difficult. After the improvement for speech has been attained, similar procedures are used for sounds such as emanate from bells, buzzers, whistles, various signals and others commonly encountered by the patient in his usual work or occupation. All work is done individually; the interval of visits is gradually increased, and treatment continues as long as progress is observed. This program may take from several weeks to several months, usually about three months. Lipreading is omitted when hearing is not severely impaired, as it distracts the patient's attention, which should be directed to auditory stimuli and away from the visual.

Final results and improvement were determined by word list scores compared with those taken before therapy. The result consisted not only of an improved understanding of speech but also of newly acquired hearing for sounds heard in households, offices or occupations. Only nine out of 46 consecutive unselected patients with varying hearing losses continued to have either a disabling or a noticeable degree of impairment. Twelve patients with a 20 to 30 decibel loss in the better ear attained a satisfactory hearing level; 18 of 21 patients with a 20 to 35 decibel loss in the better ear attained satisfactory hearing. Of the 11 patients with a 35 to 52 decibel loss, 6 reached a satisfactory level with only occasional disability, and 5 failed to improve sufficiently. Twenty-two patients of the entire

group had such discomfort in the ears as tinnitus, pressure or itching; 16 of these became symptom free, and all acquired a satisfactory hearing level. Their improvement in hearing is explained on the basis that it represents an increased use which the brain has been taught to extract from an impaired ear. The relief from the discomfort in the ear is due to relief from tension and fatigue associated with the hard of hearing state, which was improved. Patients best suited for this program are those with an average loss of less than 40 decibels between the 128 and the 8192 frequency in the better ear, especially those with an average loss between 20 and 35 decibels who can tolerate a hearing aid in very few situations during the day.

This program is indicated for patients with an average loss of 35 to 50 decibels who, because of their situation, occupation, temperament, etc., are unsuited for a hearing aid. It is also indicated for those patients who cannot tolerate a hearing aid in the better hearing ear and for those who have, because of disuse of the poorer ear, one or more of the disabilities of monaural hearing, such as turning the better ear in conversation, inability to hear voices and sounds when lying on the better ear and difficulty in localizing the source of sounds.

Practical Aspects of a Successful Hearing Conservation Program in Schools.—Kinney [56] presents the successful hearing conservation program carried out in Cleveland's schools and stresses some of the practical points and the results. A program of this nature works more efficiently when it is in the hands of those in charge of school problems and is completely divorced from all other local government activities. The program consists of screen tests carried out as group testing with the phonograph audiometer and sweep check testing with the pure tone audiometer. The latter test has been used for the past five years.

Complete individual otological examination of all students with suspected aural disability is made, together with classification and disposition of cases and, finally, adequate follow-up measures for all recommendations. The children screened are those at the 8 and 12 year level, children with known or suspected aural disease and any child who is believed to have a hearing problem, as judged by the principal or teacher. A detailed description of the technic and follow-up procedure is given. Those children requiring further investigation are referred to the otological examining center, where a thorough history is taken and examination carried out.

After the hearing situation is diagnosed, the children are classified and placed into five groups. In the first group are those with no hearing or with hearing of no more than 35 per cent in the better ear. These children are permanently transferred to a special school. In the second group are those with probable permanent hearing impairment of 45 per cent in the better ear. These children are transferred to one of the three hearing conservation centers where they have special speechreading and use the group hearing aid all day. In the third group are those with potential remedial impairments with hearing no better than 70 per cent in the better ear. These children are transferred for from one to three years to a hearing conservation center where speechreading instruction is given about one and one-half hours per day. Those with repeated temporary impairment and with hearing no better than 85 per cent in the better ear (loss of 15 per cent) are in the fourth group and receive one and one-half hours of auricular training each week. Those

56. Kinney, C. E.: Ann. Otol., Rhin. & Laryng. **58**:680 (Sept.) 1949.

who have only an occasional temporary impairment are in the fifth group and receive no special therapy.

Since 1935 over 200,000 new cases have been screened. Over this period 4.3 per cent of all children tested had a suspected hearing impairment. In the first year 92 complete aural examinations were done, and last year there were 442. In the first year 622 cases of active otitis media were discovered, while last year only 37 cases occurred in the school area, a reduction of 94 per cent. The persistent and careful follow-up procedure utilized to insure that children requiring special examinations and care actually get it is stressed as an important part of this program.

The Conservation Program in Wisconsin.—Tolan [57] presents some of the features of the conservation program in Wisconsin at a meeting of the Committee on the Conservation of Hearing from the American Academy of Ophthalmology and Otolaryngology. The main objectives of the program were early discovery of the hard of hearing patient; arrangements for corrective measures when indicated; rehabilitation of the patient; vocational guidance and assistance, and education of the otologists themselves to the realization that it was their duty to take a definite active part in doing and directing the work.

The otologists' first task was to educate all physicians and the public in general through various meetings and demonstrations. Their second task was to strengthen existing agencies doing this type of work, such as the Milwaukee Hearing Society.

A rehabilitation clinic was established at Marquette University School of Medicine. Funds were raised by donations from friends, particularly those in industry. A hearing aid bureau was established at the State Teachers' College, where there is a division for educating students in speech and hearing rehabilitation. After these services were available, arrangements were made for the periodic examination of all school children. A full-time audiologist was employed to supervise the work now going on in Milwaukee County and in three adjoining counties. Proper follow-up procedures are carried out by otologists in clinics provided for this work. This program is being extended to other parts of the State.

Hearing Foundation Established [58].—A new organization called the Hearing Foundation has been organized by the hearing aid industry. Its purpose is to launch a public relations campaign to overcome public prejudice to hearing aids; to educate the hard of hearing to the important advances in hearing aids and modern rehabilitation technics, and to develop an even greater awareness on the part of those engaged in the hearing aid industry toward the public service aspect of their business. In addition, the foundation plans to establish "Hearing Advancement Awards" to be given for outstanding work in benefiting the hard of hearing and to establish scholarships for the advanced study of hearing problems. A "Children's Better Hearing Program" is also planned to gain more attention and assistance for the 300,000 hard of hearing children in the country. The Foundation will also campaign to eliminate job discrimination against the hard of hearing in industry and to correct working conditions injurious to hearing. The Foundation is being supported by voluntary contributions from the entire hearing aid industry and affiliated industries and has the endorsement of outstanding figures among the hard of hearing and the leading medical and social welfare authorities.

57. Tolan, T. L.: Tr. Am. Acad. Ophth. **53**:567 (May-June) 1949.

58. Laryngoscope **59**:1279 (Nov.) 1949.

Function of the Otologist in Rehabilitation of the Deaf.—Stevenson [59] gives a detailed account of rehabilitation units in New York, Washington, D. C., St. Louis, Chicago and Cleveland (but he fails to mention the unit at Northwestern University). The work in these units must be done by well trained technicians and coordinated directly under the supervision of an otologist, rather than that an otologist serve merely as a consultant.

Quoting Dr. and Mrs. Ewing, of Manchester, England, Stevenson states that with use of a hearing aid alone the wearer may get 60 per cent of the words, with an aid and lipreading, 90 per cent. At the Clarke School for the Deaf, Northampton, Mass., where patients average a 72 decibel loss, 43 per cent was scored for lipreading alone; 23 per cent with a hearing aid alone, and 65 per cent with the use of both together. A much smaller percentage of patients who have had auditory training return their hearing aids than those who have not had such training. At Hoff Military Hospital, at Santa Barbara, Calif., a large number of deafened veterans who had been dismissed as unable to use a hearing aid were able to benefit from one after lipreading training. At a Naval hospital, of 2,216 patients who were fitted with hearing aids, 94 per cent continued to wear them with satisfaction at the end of 12 months.

The Physician's Responsibility Toward the Hard of Hearing and the Deafened.—Lederer and associates [60] stress the importance of the responsibility of every physician to be familiar with and to utilize the recent advances in diagnosis and treatment of hearing defects. This procedure is necessary, especially in the case of the general practitioner, who so frequently is the first one to be consulted for advice and guidance. Physicians should encourage early diagnosis of hearing loss in the infant and the preschool child and should advise the parents of the proper channels through which they may obtain help.

Facilities are available through which the parent is able to attend organized courses that explain the methods of rearing a child who cannot hear. These courses are conducted every summer by the State School for the Deaf at Jacksonville, Ill., and during the year by the University of Illinois and the Department of Public Welfare at the Illinois Eye and Ear Infirmary in Chicago. The diagnosis and training must be made and begun early.

The physician must also encourage the search for hearing losses in school children and recommend definite treatment. There are an estimated 2,000,000 children in the United States who have defective hearing in one or both ears. Careful examination and proper therapy will rehabilitate a great number of these children if the defect is discovered early. Proper routine surveys of the hearing in school children will also disclose early impairments which may be amenable to therapy. A survey of 21,000 school children in Will County, Ill., disclosed that 1,550 children, or approximately 7 per cent, had significant hearing deficits requiring preventive or active therapy.

It is also the physician's responsibility to acquaint the adult hard of hearing patient with the possibilities of medical, surgical and rehabilitative treatment. Methods and procedures carried out during the war have now been set up for the civilian population and should be utilized for proper rehabilitation. The physician must be familiar with the recent advances to advise properly and to treat the hard of hearing patient throughout his life span.

59. Stevenson, R. S.: J. Laryng. & Otol. **63**:179 (April) 1949.

60. Lederer, F. L.; Marcus, R., and Grossman, A. A.: Illinois M. J. **95**:269 (May) 1949.

A Statistical Study of Incapacitating Hearing Impairment in 1,000 Clinic Patients.—Saltzman and Everdsen [61] made a statistical study of 1,000 deafened patients who came to their clinic at Temple University because of difficulty in hearing. Institutional cases and those of total deafness were excluded from this study. This study represents an audiological survey of the deafness problem in the white population of Philadelphia and its neighboring communities in industrial cities in the temperate zone. In most of the 66.2 per cent of cases of severe hearing impairment, the etiologic factor was an abnormality of the perceptive mechanism. There was a predomination of women over men in this group, probably because of the greater longevity of the female. In the age group of 71 and over there were 125 women and 93 men. In 14 per cent of the cases the condition was diagnosed audiologically as mixed deafness, which was also slightly more prevalent in the female, the ratio being 7.8 : 6.2. Childhood deafness is most frequently of the perceptive type. A conduction lesion other than otosclerosis is seldom the cause of severe hearing loss. In 16.9 per cent of patients in this series, otosclerosis was the etiologic factor. The incidence of clinical otosclerosis is less in the male than in the female, the ratio being 1 : 3 in the white population.

Communication Technics for the Hard of Hearing.—Keaster [62] stresses the importance of properly indoctrinating and educating parents of congenitally deaf children so that they can take an active part in the training and the teaching of their children. Through the combined efforts of understanding parents and a good oral school, congenitally deaf children have a good chance to learn to communicate in a satisfactory manner with those about them. Children with impaired hearing of a nerve type have speech problems that mirror the distorted pattern that they hear. Such children can be effectively helped through visual, tactual and kinesthetic means. The otologist can be of considerable aid to such children if he can explain to the parents why these conditions exist and how they can be corrected.

Listening Eyes.—Mrs. Spencer Tracy [63] presented before the Committee on the Conservation of Hearing the program and development of the John Tracy Clinic, in Los Angeles. Its main purpose was to encourage and train the parents with deaf and hard of hearing children, particularly with children of the preschool age. The clinic is not a regular school. It has a small nursery school, and maintenance of it is only a part of the program. It is a center where parents learn not to become teachers or to take their places but to aid them and assist with home training and supplementary work. Much of the work is carried out through correspondence courses. In six years, more than 2,000 mothers have been helped to understand and to do their job. In addition to the service of the small nursery school, the Clinic sponsors individual consultations, a correspondence course, a summer school and replies to personal letters requesting information or assistance. The program is maintained by voluntary contributions, and there is no charge for any of the services. The correspondence courses are available to parents of deaf children under and including 6 years of age who are not yet in school. They are available for any place in the world that can be reached by mail.

61. Saltzman, M., and Everdsen, M. E.: Ann. Otol., Rhin. & Laryng. **58**:345 (June) 1949.
62. Keaster, J.: Tr. Am. Acad. Ophth. **53**:581 (May-June) 1949.
63. Tracy, S. (Mrs.): Tr. Am. Acad. Ophth. **53**:583 (May-June) 1949.

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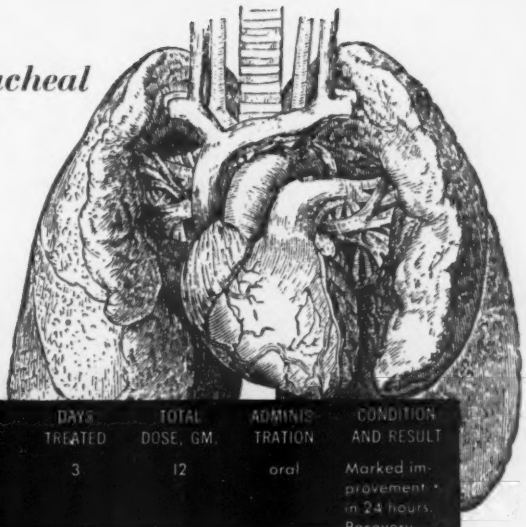

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1. Welch, H.; Hendricks, F. D.; Price, C. W., and Randall, W. A.: J. A. Ph. A. (Sc. Ed.) *39*:185 (Apr.) 1950.
2. Knight, V.: New York State J. Med. *50*:2173 (Sept. 15) 1950.

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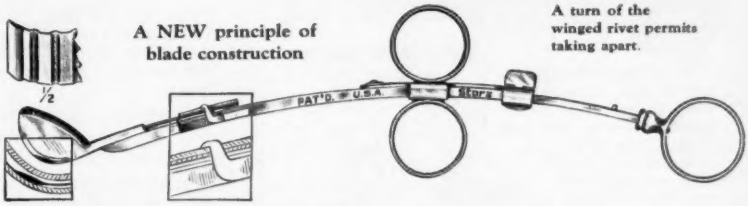

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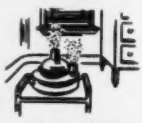

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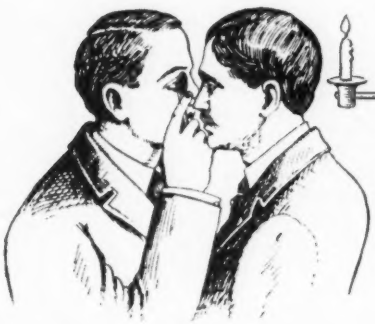
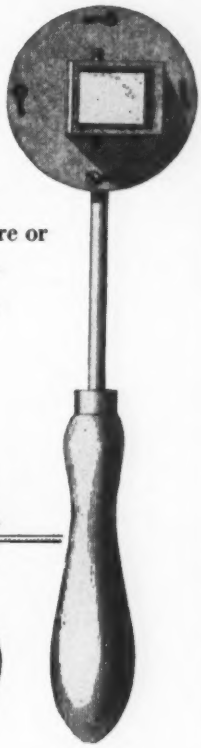


Reproduced from an early drawing showing the ophthalmoscope in use.



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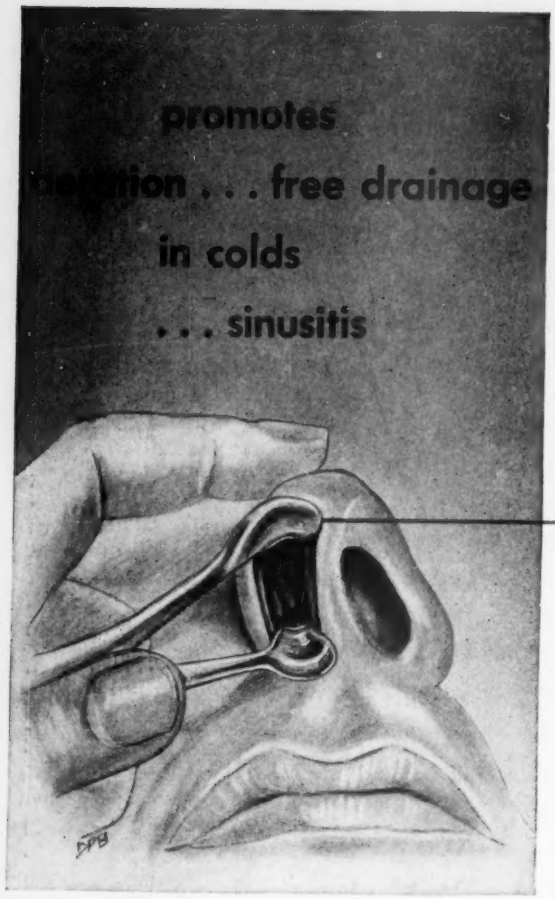
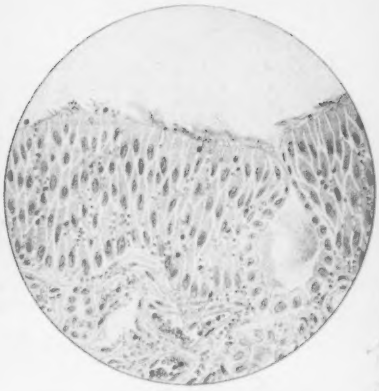
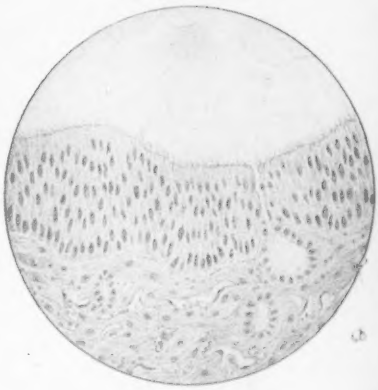




Nasal membrane showing increased leukocytes with denudation of cilia.

Normal appearing nasal epithelium.



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